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CONTENTS.

ARTICLES.	PAGE
1. The Vehicle of Force. By CHARLES MORRIS	607
2. Exploration in the Far East	620
3. The Phenomena of Fluorescence. By E. R. HODGES	625
4. Gilbert White Reconsidered	632
5. The Four Forces of Nature. By G. WHEWELL, F.I.C., &c.	639
ANALYSES OF BOOKS.	
Nature's Hygiene	644
The Truth about Vaccination	646
The Brain as an Organ of Mind	648
Abstract of a Discourse on Ornament	651
The Life of Thomas Wills, F.C.S., &c.	652
ANALYSES OF BOOKS—*continued.*	
Journal of the Society of Telegraph Engineers	653
Histoires des Coléoptères de France	654
Revue Internationale des Sciences Biologiques	655
Traité d'Anæsthésie Chirurgicale	657
Report upon Cotton Insects	658
What constitutes Discovery in Science?	660
Elements of Chemistry, Theoretical and Practical &c., &c.	661
CORRESPONDENCE	665
NOTES	667

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THE

JOURNAL OF SCIENCE.

OCTOBER, 1880.

I. THE VEHICLE OF FORCE.

By CHARLES MORRIS.

MODERN thought has made so many valuable conquests in the outlying districts of the kingdom of Science that it is daily drawing nearer, to the citadel of the kingdom, that abstruse question of the ultimates of Nature on which so much deep reasoning has been expended, yet which still remains unsolved. The whole process of thought in this direction has been a process of simplification. A century ago a very complex conception of these ultimates was entertained. To ordinary matter was added an indefinite number of imponderables, while the forces of attraction and repulsion were neatly parcelled out among these various forms of substance, until the whole affair became unpleasantly intricate. As for motion, there had been some inquiry into its laws, but very little consideration had been given to its office as a primary constituent of Nature.

We have changed all that. The imponderables have ceased to be substances, and have become special modes of motion; and Nature is being reduced in theory to two ultimates, matter and motion. True, matter has not quite reached this degree of simplification. There still underlies it a vague conception of an unparticled Ether, the supposed vehicle of radiant force. This ethereal constituent of Nature has been found necessary by two classes of reasoners,—the students of the science of Optics, and the promulgators of force theories. It has seemed impossible to explain Attraction and Repulsion as attributes of a single form of matter, and theorists have found themselves obliged to deal with two diverse substances, through whose aid they neatly make

the whole business clear—to themselves. Another class of reasoners, the advocates of what we may call the pressure and shelter theory of matter, have sought to get rid of these forces altogether, and explain them as results of momentum. But in doing so they have raised new difficulties, almost or quite as great as the old ones they have avoided.

The true origin of force still remains a mystery, despite the theoretical attempts above mentioned. Yet the intense thought which has been expended on the effort to connect attraction and repulsion with matter, without satisfactory result, goes far to indicate that theorists have been clinging to a false conception, and wasting their powers on a stubborn effort to prove the impossible. There is, however, another point of view from which the question may be considered, which, strangely enough, seems to have never been attacked, and which I propose to consider in the present article.

If we take it for granted that attraction and repulsion really exist, as forces distinct from the impact force of momentum, certain necessary deductions follow. Not being motion they cannot be converted into motion, although long arguments have been made on the tacit assumption of such conversion. The quantity of motion in the universe is supposed to be unchangeable. Attraction and repulsion, not being motion, cannot add to nor take from this total quantity. And yet bodies, which were apparently at rest, start into visible motion under their influence, and our works on physical science are full of argument which amounts simply to a declaration that motion is created by attraction. For the theory of potential and actual force can be given no other interpretation. Disguise it as we may, potential force means simply possibility of motion. Actual force means real motion. Thus, in the accepted theory, there lurks a distinct claim of the creation of motion, the possible being converted into the actual under the influence of attraction and repulsion.

I have already dealt with this question in my article in the June number of the journal, on the modes of interchange between heat motion and mass motion. I have there sought to show that attraction and repulsion have not a creative—but simply a directive—power, and that all the motion which springs into visible existence had a previous invisible existence, the vibrations of particles being readily convertible into the onward movements of masses, and the latter as readily transformable into heat vibration.

We are thus enabled to somewhat simplify the question as follows :—There exists an unvarying quantity of matter,

possessing, perhaps, the quality of existence only; an unvarying sum of motion, which yields matter the energy of momentum; and a directive principle, known as attraction and repulsion. No matter how vigorous this latter force, it is not motion, and therefore cannot add to nor subtract from motion, nor is it convertible into motion. It is limited in its action to the changing of the direction of moving matter, thus exerting a force, since matter retains its direction of movement with a certain energy.

The question to be solved is, What is the origin and character of this directive force? where shall we seek for that vital principle of Nature from which arise the various manifestations of directive influence known as Electricity, Magnetism, Chemism, and Gravitation? As we have already stated, it has always been assumed that this force is an attribute of matter, and men have shut their eyes to certain striking indications of nature, in their efforts to establish untenable hypotheses, based upon this false conception. Yet it is simply impossible to comprehend that two similar particles can now attract and now repel each other, from any principle inherent in themselves, while the idea of a self-repulsive ether and an attractive matter makes of nature a very intricate affair.

But it may be argued that the particles of matter are not similar, that they attract under one set of conditions and repel under another. Yet this does not dispose of the difficulty of their possessing two opposite forces as inherent attributes. It leads us, however, to the possibility of another interpretation of the question. For this difference in condition means, in many cases, and perhaps in all, a difference in motive relations. The matter may continue the same, but its internal movements have varied, and its force influence upon other substance varies accordingly.

Does not this yield us a new conception? If the attractive and repulsive energies of matter interchange as its motive relations vary, it naturally seems as if these energies had more to do with motion than with matter; as if, in short, attraction and repulsion were inherent attributes, not of matter, but of motion. And, again, if attraction and repulsion be simply directive energies, their whole influence consists in producing changes in the direction of motions; and it is certainly as easy to conceive that motions exert this influence upon each other, as to suppose that it is exerted upon them by matter. All the results of directive force are variations in motion, and it is very natural to conclude that the force itself is an attribute of motion.

If we approach this subject more closely, we at once perceive that at least two of the four special manifestations of this force spring from motive conditions. These four manifestations are Electricity, Magnetism, Chemism, and Gravitation. Chemism, however, has probably nothing special in itself, but is more likely a result of the other three modes of energy; as are also the cohesive and adhesive displays of force. But of the three other manifestations of directive force there is abundant reason to believe that electricity and magnetism are modes of motion, while we are as yet unaware of the cause of gravitation. If the electric and magnetic energies, then, arise from special conditions of motion, and if their sole manifestation—beyond that of motive vigour—is attractive and repulsive force, we certainly have some warrant to conclude that this force is an attribute of the special motions with whose birth it is born, and with whose death it dies.

We may safely take it for granted that the directive energy is not an attribute of both matter and motion, arising from the innate constitution of matter, and also from the innate energy of motion. Such an attribute cannot possibly belong to two distinct ultimates of Nature—to concrete matter and to abstract motion. It must appertain to one only. But if we impute it to matter there arise certain mysteries which still remain unsolved, despite numberless attempts to explain them:—First, how it can exist in two directly opposite forms; secondly, how it can increase and diminish in quantity; thirdly, how it can be transferred from one substance to another; and finally, how it can utterly disappear in one form without any apparent change into another form. If, on the contrary, it belong to motion, all these difficulties at once vanish. Motion readily assumes directly opposite conditions; it readily varies in quantity in any substance or part of a substance; it is readily transferred from one body to another; and, finally, it may so change as to produce neutral relations, with complete disappearance of directive force. Thus the many objections which apply to matter as the vehicle of force all disappear if we ascribe this attribute to motion.

Such a transfer of directive force is one of the most common manifestations of electricity. Static electric force, for instance, spreads from a point over the whole surface of a conducting body, and leaps from one conductor to another, carrying with it, in all its movements, attractive and repulsive vigour. Now the transfer of electricity is simply the transfer of a mode of motion; therefore the force transferred

with it must be the movement of a force pertaining to motion. For the outgoing motion could not conveniently sweep away inherent force from one substance to plant it in another; nor could a force attribute of matter well go to sleep in one mass the instant motion left it, and awake in another the instant motion entered it. Similar shifting phenomena of force might be shown in other instances of the transfer, or the sudden action, of motive energy, all tending to strengthen the position we have taken. But without specially considering them here we will try to deduce from the force manifestations of Nature the law which governs this directive principle of motion.

Our work is, in fact, largely done to our hand, by the investigators of electrical phenomena. We know that if electrical currents are sent through two contiguous wires, these wires exert a marked influence upon each other. If the currents proceed in the same direction, the wires are drawn together. If in opposite directions, they are mutually repelled. In this case substances, which previously had no apparent influence upon each other, are by the addition of motive energies exerted in similar directions, caused to approach, and to separate if the energies move in opposite directions.

In the case of magnetism the same result appears, since magnetism is believed to be an effect arising from the circling of motive vigour around the particles of matter, magnetic attraction arising from parallelism in these motions, and repulsion from reversal of their directions. The inter-actions of electric and magnetic force yield the same result, masses of matter being moved in the effort to produce parallelism of motion. The full expression of the principle involved is the following:—Motive currents which move towards or from the same point in space, atttract; while those that move one towards and the other from a point, repel.

May we not have here a ready solution of the whole difficulty of these forces? Matter cannot well change its character, but motion can very readily change its direction; and the above principle may cover the whole question. We may, in fact, formulate a law of directive force as follows:—All matter in motion exerts an influence over the direction of all other matter in motion, this influence proceeding from motion disappearing with the cessation of motion, and augmenting with its increase. Any two motions parallel, or tending towards or from the same point, are forced to approach each other. Any two motions reversely parallel, or

tending the one to, the other from, the same point, are forced to recede from each other. And the vigour of this influence is probably governed only by the energy of the motions and the distance separating them,—not at all by their degree of approach to parallelism.

All motions, whatever their direction, must, under the operation of the above law, exert an influence, either attractive or repulsive, upon all other motions. There can be no neutral state in which both these influences will disappear. For a close observance of the possible directions of two lines of motion, which end in or tend towards the same point, shows that they must hold toward each other one of the above relations, and that no intermediate relation is possible. They must either both approach or both recede from this point, or one must approach and the other recede. But in the case of motions which do not tend to or from such a point, and are not parallel, conditions of both attraction and repulsion might exist between their different parts. A great variety of relations might thus arise, in some of which the opposite influences might become balanced, and neutrality arise through opposition, not through loss of force.

Motions also may readily become reversed, with a consequent reversal of their forces; and if this reversal is rapid and incessant the effect of neutralisation will be produced. Such is the case in heat vibration. A vibrating particle reverses its relations of motion to all contiguous particles at every change of phase in its vibration. Thus its influence constantly shifts from attractive to repulsive, and the contrary, and its force effect is virtually neutralised. An analogous condition may arise in the case of magnetic substance. When its internal movements are largely in the same direction the magnetic phenomena appear. When not largely in the same direction their external influence becomes neutralised, the attractive and repulsive forces of the various particles balancing each other.

But although positive neutrality cannot exist between two motions, it may easily exist between motion and rest; for if force is an attribute of motion, changing in vigour as motion changes in energy, a particle at rest must cease to exist so far as the exertion of force is concerned, since with the disappearance of its motion its force display must likewise disappear. In like manner a particle approaching rest must decrease in force through the diminution of its momentum; at the same time the force exerted upon it by other matter must similarly decrease. The force exerted between any

two particles, at a fixed distance apart, depends upon their momentums. If we assume a unit of momentum, then the force exerted must depend upon the number of these units of moving energy. Consequently a small quantity of matter might exert as effective a directive force as a large quantity, if the former move with sufficient rapidity to equalise their motive energies. In all cases they must exert an equal attraction or repulsion upon each other. For if one mass be conceived to have ten units of momentum, and another mass one unit, the latter acts with its unit vigour on each of the ten units, giving it ten elements of force. But each of the ten units of the larger exerts but one element of force on the one unit of the smaller, giving it likewise ten elements of force. The fact is that the force vigour exerted upon each other by any two masses in motion is always equal, but is not equally effective in speed production unless they are of equal momentum. The larger momentum resists change in direction more vigorously; but the quantity of effect produced upon the inertia of motion is always equal, whatever the difference in momentum of the acting masses.

Thus the utmost vigour of directive force is exerted when two bodies move with equal rapidity, and at the highest possible speed; it diminishes in vigour as one or both of the bodies lose speed; it becomes null when one or both attain a condition of rest; and it changes in direction when either body reverses its direction of motion.

It might, however, be deduced from the above argument that a vibrating particle, on coming to rest at one extremity of its vibration, could not move again, it losing, while in that state, all force relations with the neighbouring particles. Such might be the case had it no other motions; but it is at rest relatively only, not absolutely. Besides their motions of organisation—which we will not here consider—all particles are in constant general motion, and a relative position of rest is only a diminution of some of these common cosmical motions. A particle at rest, in the ordinary acceptation, is one obeying its cosmical influences only. One possessed of special motion is obeying some local influence. These common cosmical motions—such as the mutual movement of particles in the rotation of the earth on its axis, and in its revolution around the sun—must act to render the great sum of motions parallel, and the great sum of forces attractive. Repulsion is not, in the present condition of matter, a general affection of nature, at least in so far as affairs on the spheres are concerned. It appears only

in local disturbances of the great sum of parallel motions. In fact all the special force phenomena of Nature are consequences of such local disturbances, and produce but temporary variations in the general vigour of attractive energy.

But if, as we have argued, both impact force and directive force are results of momentum, it may, at first sight, seem as if matter had something to do with them, for at equal speeds the vigour of momentum depends upon the quantity of matter. And yet, in reality, matter has nothing whatever to do with momentum, which is a property of motion alone. In momentum only the vigour of motion is concerned; in no sense the quantity of matter. For the motive vigour which moves one mass of matter at a certain speed will move half that mass at a double speed. And if this motive vigour be successively transferred to gradually decreasing masses it will move them more and more rapidly, the momentum remaining the same though the quantity of matter be infinitely varied. If, finally, the mass of matter be diminished to its vanishing point, the speed of motion will rise to infinity, the momentum continuing unchanged. Momentum, then, is not a property of matter, but of motion; and if impact and directive force are both controlled by momentum, they are attributes of motion only, and matter has no office in Nature save to serve as the vehicle of motion, it being the concrete substratum through whose aid motion attains manifestation, and becomes capable of assuming the most varied and complex arrangements, yielding intricate relations of force.

But there is a secondary result of the law of force which is one of the most active influences in Nature, and which we must now consider. Directive force, as we have argued, tends to draw bodies together or to drive them apart. But ordinarily this tendency is resisted and becomes ineffective. So far, for instance, as the mutual cosmical motions of particles are concerned, every particle may be so placed that the attractive energy arising from these motions affects it equally from opposite directions, and thus becomes neutralised. Only when some local aggregation of momentum causes the attraction in one direction to overbalance that in the other, does movement in response to attraction result. There is thus a constant tendency in the motions of particles to become parallel, in response to their cosmical relations, while their local movements are only minor deviations from this persistent line of direction.

But they not only tend to become parallel in direction,

but also equal in speed. Although the opposed attractions permit the particle to retain its general direction of movement, they tend to drag it back when its speed becomes too great, and to drag it forward when its speed becomes decreased, until equality of speed is attained. The forces which oppose and neutralise each other directly aid each other transversely, so that, while the direction of motion remains unchanged, its speed is controlled, the constant tendency being to produce equality of speed in all similarly moving particles.

Such is the influence at work in radiant impulses. Every new motion given to a particle exerts this influence on all neighbouring particles, and is transferred from particle to particle with wonderful rapidity. Its primary tendency is to drag neighbouring particles towards itself; but if this tendency is resisted through a similar drag in the opposite direction, it can only exercise its secondary tendency to drag the adjoining particles into equality of speed, and to yield to a reverse drag from them, the motive energy lost by the one particle being gained by the other. But it is only to the origin of this effect, not to its details, that we wish to here refer.

There remains another force agency to be considered—the generally diffused and unvarying attractive force of gravitation. Investigation has hitherto been principally directed to the effects, not to the origin of this force. Yet it seems as if, under the above hypothesis, gravitation may receive a definite place among the modes of motion.

The gravitative force of a particle has nothing to do with its fugitive special motions, which influence its behaviour towards its neighbours, but which vary in a manner to neutralise their influence on the great attracting masses of the universe. Its special motions, indeed, are but temporary deviations from its general cosmical motions, and the tendency to resume the normal state causes any deviation in one direction to be balanced by an equal opposite deviation, so that all effects in one direction are neutralised by equal effects in the opposite direction. But these cosmical motions may have a fixed and persistent gravitative influence. Thus the movements of the particles of the earth in its orbital revolution constitute a vigorous momentum, which should yield some degree of attractive influence upon the similarly rotating sun. In like manner the rotation of the sun upon its axis should yield a like attraction upon the similarly moving planets. The axial rotation of the earth should also create an attraction between its parallel lines of

momentum, tending to draw all these lines of motion towards their general centre of influence.

If our principle be correct, these motions certainly have a gravitative influence. The equatorial regions of the earth rotate at a speed of about 1000 miles per hour. But the earth moves around the sun at a speed of over 1000 miles per minute—in round numbers, about 18 miles per second. Here is a vast mass of momentum all of whose influence must be attractive, since all its motions are in one direction. Its effect must be double. It must yield a centripetal influence, adding to the great sum of terrestrial gravity. It must also yield a centrifugal influence, extending to all similarly moving matter in space, and acting attractively upon the sun and its attendant planets. If such be the case the gravitative force of a planet could not be measured by its density or mass of matter alone, but must be to some extent influenced by its orbital momentum.

Yet this could be only an aid, possibly only a slight aid, to the full force of gravitation, since the latter must be largely due to atom attraction, proceeding from the deeplying fixed motions supposed to exist in atoms.

It may be advisable here to consider the character of this supposed atom motion. The theory that atoms are minute vortex rings of ethereal substance has many points in its favour, although it is not easy to conceive how such vortex rings could arise in the original ether, since its conditions were certainly not those of ordinary fluids. Yet if the ether possessed inter-movement, with its consequent attraction, we can readily conceive of a condition arising similar to another probable condition of fluids, viz., an aggregation around a common centre of attraction, and possibly the formation of permanent spherical or discoidal masses through the influence of rotation about an axis. And upon such masses, if forced to move through the ether, secondary vortex-forming influences might act, similar to those which act upon moving fluids. Such a process of formation would give a double motion to the atom, it possessing not only the peculiar motions requisite to the vortex ring, but also a rotation of the ring as a whole around its axis, or the common centre of its material. In such a case the atom would be at once a collection of individual particles and a single mass, these particles pursuing the vortex movements as individuals, and the whole ring its axial rotation as a mass.

In such a rotating ring opposite influences must exist. Its parallel movements must yield an attractive force, and constitute centripetal influences, tending both to the centre

and to the cylindrical core of the ring. But in every circle of motion the opposite arcs move reversely, and must therefore repel, producing a centrifugal force. Of these two forces the centripetal must be the strongest, since its influence is exerted at the least distances, but the density of the mass and the diameter of the ring must be a resultant of the action of these opposed forces.

The energy of such an atomic mass would depend not upon its quantity of substance, but upon its momentum. If all force is dependent upon motion instead of upon matter, two atoms widely differing in material contents might be equal in vigour if their momentums were equal. Atoms may thus be almost infinitely minute, and the total quantity of matter in the universe be insignificant. So long as a fixed energy of motion exists it is unimportant what quantity of matter serves as its vehicle.

This atom motion is possibly of extreme rapidity, constituting a vigorous momentum, and forming the main factor in the general sum of gravitative force. On the supposition that atoms are minute masses rotating around a central axis, they must in reality constitute small magnets, the directive force arising from their motion fulfilling all the requisites of the electric currents of Ampere. If one pole of the axis of motion be presented, the whole axial momentum of the atom must exercise an attractive energy. If the other pole be presented the momentum must act repulsively. (If the atom be really a vortex ring, its vortex motion must produce special deviations in these results.) If the equatorial plane be presented attraction and repulsion would not necessarily become neutralised. One half the momentum would oppose the action of the other half, but one half would be nearer the substance acted upon than the other half, so that one or the other energy would be in excess. It is probably this excess which constitutes the innate attractive force of atoms, considered without reference to their magnetic augmentation of force. The latter probably acts vigorously in the chemical relations of atoms, and causes the atoms composing molecules and masses to arrange themselves under the control of local influences, and without special regard to cosmical influences. Yet this would not necessarily hinder their cosmical relations continuing fixed in degree and direction.

For the combinations of atoms into molecules are never irregular. The crystallising tendency which controls the minor aggregations of masses doubtless controls still more vigorously the formation of molecules. The minute elements

of molecules are regularly combined under special conditions of attraction, and their motions are forced to harmonise with each other, every deviation from the general direction of motion, caused by the exigencies of the crystalline relations, being balanced by an equal opposite deviation.

But the directive influence of these crystalline factors of masses acts upon and is reacted upon constantly by the immense directive vigour of the earth, which may exercise a leverage upon all molecules, forcing them to assume a general conformity in direction. Whatever change in position may take place in masses, their molecules do not necessarily change in accordance therewith. For molecules are not rigidly fixed elements of masses; spaces separate them, in which they possess a certain degree of liberty to move and rotate. Thus they may readily yield to the leverage of terrestrial force, and shift their axial directions so as to retain one fixed relation with this force in every change of direction in the masses containing them.

Yet, supposing molecules to be a combination of more minute atoms, it does not follow that these atoms would have an equal facility of movement. They must be more rigidly constrained, through their closer proximity to each other and their more vigorous attractive relations. Possibly different substances vary in the character of their relations to exterior force. In some the molecules of masses may be as rigidly constrained as we suppose the atoms of molecules to be. In such a case, if these molecules be made to conform in direction through exterior influence, they would continue to do so with an energy affecting the whole mass, and the phenomena of permanent magnetism occur. This magnetic condition may ordinarily exist in molecules even when not displayed in masses, the molecules assuming positions in accordance with terrestrial magnetism, except when they are acted upon by local magnetism. And there may be cases in which the axes of rotation of molecules assume directions, under exterior influence, not in harmony with the direction of their atom forces, thus yielding the diamagnetic repulsion.

If the internal conditions of bodies be such as we have here surmised, it seems as if the ordinary tendency of molecules must be to direct their axes north and south at the Equator; for we naturally conclude that the rotation of the mass of the earth around its axis must yield a directive energy forcibly tending to bring the motions of all its minor constituents into harmony therewith, the axis of motion of every molecule at the Equator becoming parallel to the

earth's axis, and the direction of motion similar to that of the earth. Where these molecules are rigidly constrained elements of masses, as in permanent magnets, the axis of magnetism must assume a like parallelism, the whole mass being moved by this form of terrestrial force. And molecules and magnets alike must behave with the earth as one magnet would behave with another; that is, the magnetic dip must occur, the magnet becoming vertical at the pole, since there its axis must become virtually an extension of the earth's axis, to preserve the conformity in their movements. Local displays of magnetic energy must act like all other divergencies of motion from its normal relations, to temporarily vary the vigour of gravitative force. The normal conditions of motion are those possessed by spheres as wholes, and the rotations of molecules in harmony with those of their spheres. All other motions are discordant and temporary, their influence being to temporarily increase or diminish the gravitative force of the abnormally-moving particles. It is in these abnormal motions, not in gravity, that we see the full vigour of atom force. It is partly shown in magnetic action, but more fully in chemical action, in which its great energy is strikingly displayed.

The conformity in motion which we have thus supposed to exist throughout the earth probably extends throughout the solar system, and possibly through the whole astral system of which it forms a part. Yet, as the earth does not rotate in strict parallelism with the rotation of the sun, the molecules of the earth may be affected to some degree by this solar rotation, and their axes assume a position intermediate between the direction required by these diverse forces. In like manner the moon and the planets undoubtedly exert a similar influence, so that the true direction assumed by the axes of terrestrial molecules is a resultant of numerous diverse but closely-related influencing forces. And these forces are not fixed in direction and degree, but are constantly varying, there being daily, yearly, and other much longer periods of variation.

From these variations there may arise the regular variations in terrestrial magnetism, which have like periods of change. As for the irregular variations, known as magnetic storms, there is no reason to doubt that they are usually caused by sudden changes in the condition of the sun's surface, by convulsive movements which may well produce a striking temporary variation in the relations of the molecules over an extensive portion of the solar sphere, and thus in the sympathetically connected molecules of all the planets.

It would appear then, if our premises are correct, that the directive influence exerted by the cosmical motions of the sun and the planets upon any one of these bodies must act to cause all the molecules of that sphere to assume an axial direction in accordance with these influences, so that the movements of all the molecules of the solar system may be in general harmony, the motion of each being a resultant of the many directive forces acting upon it. From the attractive influence exerted between all these similarly-moving molecules, gravitative attraction would arise. If this be the case the vigour of attraction arising from the movements of the spheres would be exerted upon their molecules, in producing conformity of motion, while the force of these latter would react upon each other, and thus upon the spheres as wholes, forming the attraction of gravitation.

In regard to the relations of diverse solar or astral systems, repulsion may take the place of attraction, if their general motions be reverse to each other, so that the attraction of gravitation may not be a universal force, but may be neutralised or reversed between different systems.

II. EXPLORATION IN THE FAR EAST.*

SINCE the days of Sir T. Stamford Raffles, of Sir James Brooke (much maligned of anti-nationalist orators), and still more since the publication of Mr. Wallace's fascinating work, it may safely be said that no part of the world has so much attracted the attention of naturalists as the Eastern Archipelago. The number, the variety, and

* Der Malayische Archipel. Land und Leute in Schilderungen gesammelt während eines dreissig-jährigen Aufenthaltes in den Kolonien. Von C. B. H. von Rosenberg, Königl. Niederländisch-Ostindischer Regierung's-Beamter, Ritter hoher Orden, mehrerer gelehrter Gesellschaften Mitglied. Mit zahlreichen Illustrationen zumeist nach den Originalen des Verfassers, und einem Vorwort von Professor P. J. Veth, in Leiden. Leipzig: Weigel. Amsterdam: De Bussy. London: Trübner and Co.

(The Malay Archipelago. Land and People in Representations collected during a Thirty Years' Residence in the Colonies. By C. B. H. von Rosenberg, with numerous illustrations from the author's original sketches, and a Preface by Professor P. J. Veth, of Leiden.)

the beauty of both animal and vegetable forms of life, and still more the peculiarities of their distribution, have made these islands the very Mecca of botanists and geologists. The appearance of the present work has therefore been eagerly expected. The thought suggested itself at once—If Wallace has observed and recorded so much in a residence of eight years, what must not Von Rosenberg have effected in thirty, and with the additional advantage of visiting not a few islands where Wallace never set foot, and especially of examining a much larger portion of New Guinea!

Further reflection will show that these demands are exorbitant. Mr. A. R. Wallace's whole time was devoted to Science, and his going and coming were regulated accordingly. Von Rosenberg was for twenty years in the military service of the Dutch Government, and his opportunities for observation depended on his duties as an officer. During the last ten years of his sojourn in these lands of wonder and beauty he held, indeed, the appointment of Surveyor and Naturalist; but a very great part of his time was compulsorily devoted to a topographical and statistical examination of the islands. Latitudes and longitudes had to be determined, bays and rivers measured and sounded, villages noted and their population enumerated. Great attention was also paid to the manners and customs of the inhabitants, their religion, architecture, language, &c., as also to the meteorological and sanitary conditions of every locality visited. That in this manner a great amount of useful information was collected—some of it of high scientific value—is manifest; but the time and opportunity for observations in natural history, strictly speaking, were sadly narrowed.

The author's investigations extend to Sumatra, the smaller islands along its western coasts, Celebes, the Moluccas (including Ceram), the Aru, Ke, Matabello—or, as he writes it, Watubella—Islands, Waigiou, Ternate and Tidore, and New Guinea. On the coasts of Sumatra, and subsequently in the Moluccas, he observed a curious and obscure phenomenon:—At night the sea over the reefs emits a peculiar sound; at the depth of 20 feet it is like the crackling of salt when thrown upon burning coals; at 50 feet it sounds like the ticking of a watch, and is repeated more or less rapidly according as the bottom consists of coral alone or of coral intermingled with sand and mud; over mud-banks it resembles the humming of bees. Of the marine fauna of the Sumatran coasts he speaks with enthusiasm.

Brakian he describes as an El Dorado for ornithologists and entomologists. Among the more characteristic butterflies he mentions *Papilio palinurus*, *P. pompeius*, *P. antiphus*, *P. theseus*, *P. priapus*, and *P. memnon*. The European hawk-moth, *Sphinx ocellata* (*Smerinthus ocellatus*) occurs here.

The orang-utan of Sumatra is confined to the flat, swampy coast-forests extending from Tapanoli to Singkel. It is named by the inhabitants "Mawas," and may be distinguished from the Bornean variety by its more foxy-red colour. The remaining Sumatran apes are *Hylobates syndactylus* (the amang, improperly termed siamang) and *H. agilis* (ungko), inhabitants of the mountain-forests; *Semnopithecus cristatus* and *S. melalophus*, *Cercopithecus cynomolgus*, and *Innuus nemestrinus*. The bats (*Pteropus*), during the author's residence at Lumut, flew every evening in a swarm from the north-west towards the south-east, and returned before sunrise in an opposite direction. The author fired once at a female which was flying unusually low, when a young one which was clinging to her teats fell downwards: before it could reach the ground the mother darted after it, seized it with her teeth, and soared away with her rescued offspring.

The fort was almost besieged by tigers, so that no one ventured to go out after six in the evening. The animal differs in some respects from the Bengal race. The ground colour is less of a rusty red, and the black stripes are not so slanting, and do not display upon the back those sharp angles, directed forwards, which form a black dorsal stripe in the tiger of the Indian continent. In the Sumatran race the tail is shorter and thinner. Elephants, identical with the Geylonese species, are tolerably numerous. The rhinoceros (*R. sumatranus*) is met with in the mountains as high as 6000 feet above the sea-level. The author gives a very extensive list of the birds of Sumatra, in many cases with remarks on their habits and structure, which, however, space does not allow us to notice.

The islands on the western coast of Sumatra are rich in Coleoptera and Lepidoptera of remarkable beauty. One species of the latter, *Hebomoia Vossii*, is peculiar to the Isle of Nias. The author observed no mammal or bird which is not common to Sumatra, whilst all the larger members of the former class and many of the Sumatra are wanting. There are neither tigers, bears, elephants, rhinoceros, or tapirs. Only two monkeys occur, and these are absent in Engano, the most southern, and in the author's opinion the most recent, of these islets.

Celebes has been very thoroughly investigated by Herr von Rosenberg. At Ajer-Pannas, on the north-east coast, are mineral springs, rich in calcium chloride, and of the temperature of 171° F. For the entertainment of distinguished visitors it is customary to capture crocodiles and plunge them into the hot water, where they speedily perish. At Sumalatta the chief object of interest is the deposit of copper and iron ores, alternating with auriferous pyrites. Latterly the workings have been abandoned, the miners have left the district, and the garrison has been removed.

At Linu is a lake of boiling mud. Here Count Vidua de Conzana, a distinguished Italian naturalist, perished miserably, having fallen into the mud up to his hips.

The author agrees with Mr. A. R. Wallace in regarding Celebes as the terminal point of the Indo-Malayan and the beginning of the Austro-Malayan fauna. He mentions *Cercopithecus cynomolgus* as very common in the southern part of the island, and extending into the territory of the Australian fauna. *Cynocephalus nigrescens* he considers a local variety of *C. niger*. It is very numerous, and when in large bands will sometimes attack a solitary traveller. Their presence in Batschian is explained by the fact that a pair of these apes were set at liberty by the grandfather of the reigning sultan. *Tarsius spectrum* is by no means so ugly as it is figured by Horsfield in the "Zoological Researches." A valuable catalogue of the birds of Celebes concludes this section. The author's collections and those of Bernstein have added eight species to those given by Wallace. He remarks that though the avi-fauna of Celebes is poorer, both in species and in brilliant colouration, than those of the Moluccas and of New Guinea, it surpasses those of Java, Sumatra, and Borneo in the development of certain families, especially the parrots, kingfishers, and pigeons.

On pedestrian tours across the island of Ceram he secured a rich harvest of insects, such as *Ornithoptera Priamus*, *O. Remus*, and *O. Hellene*, *Papilio Codrus*, *P. Sarpedon*, *P. Ulysses*, *P. Amphytrion*, *P. Severus*, *P. Deiophobus*, &c. These species haunt the banks of the streams which are filled with water-worn stones. Here it appears that he found Mr. A. R. Wallace, whose acquaintance he had previously made in New Guinea.

The ethnologist will here find an account of the Kakean League, a secret society which sprang up in the seventeenth century, and whose object is to prevent the spread of Christianity and Islamism. The Ceramese are Pantheists.

The Aru Islands were found especially abundant in Lepidoptera, including the magnificent *Cocytia d'Urvillei*.

The author's account of the birds of Paradise of Aru and the neighbouring islands is very complete. He describes *Paradisea apoda* and *P. regia*. We cannot refrain from expressing our fears that this splendid family will soon be extirpated, except the use of the birds for the decoration of persons, rooms, &c., be prohibited.

At Ternate the author visited the grave of his distinguished predecessor, Dr. H. A. Bernstein, who died at Batanta in 1865.

Herr von Rosenberg's visits to New Guinea comprise an examination of the south-west and north-east coasts, a journey to Geel Vink Bay, and an expedition to Andai by way of Batjan. He considers that only an insignificant fraction of the fauna, and still more of the flora, of this marvellous island is as yet known to Science. His expeditions appear to have been made chiefly in the rainy seasons, when both collection and observation are much impeded. Nevertheless he studied with care and success the splendid genus *Epimachus*. He is the first European who met with *E. speciosus* "in the flesh," all specimens formerly obtained having been skinned and spoiled by the natives, who are the vilest of taxidermists.

Our author's account of his visit to Java is substantially a description of the admirable Botanical Gardens of Buitenzorg, maintained by the Dutch Colonial Government. These gardens contain 251 families, 2305 genera, and 8506 species of plants. For the benefit of plants that require a cooler climate there are branch establishments in the mountains, one of them on the summit of Pangerango, 9600 feet above the sea-level.

An appendix contains a description of species of birds which the author has discovered, or at least has had the opportunity of examining more closely than had been done before.

In this short survey we have necessarily been able to refer only to a very small part of the interesting matter contained in this work, which we strongly recommend to all who are interested in the geography, the ethnology, and the natural history of the Far East.

III. THE PHENOMENA OF FLUORESCENCE.

By Edward Rattenbury Hodges.

NOW and then it happens that Dame Nature "lets the cat out of the bag," or, to speak more philosophically, she reveals some hitherto unnoticed and unknown fact or phenomenon which takes us by surprise.

The exhibition of this to the young or old, the learned or unlettered, is invariably followed by the ejaculation—How beautiful! how wonderful! No matter how diversified our habits, gifts, or tastes, we feel a common interest in the thing, and mutually share the sentiment of pleasurable surprise. We think it may fairly be said that the movement of a comet through space, or the motions of a creosote-drop upon a water surface, are alike equally worthy of our attention and our thought; for He who made the glowing gases of the one also formed the oily particles of the other, and fully intends us to augment our knowledge and exercise our reasoning faculty as much by a careful contemplation of these as of other phenomena. By this delightful mental exercise we insensibly learn to observe and reflect at one and the same time, in consequence of being brought into direct contact with what a great leader in Science has aptly termed "objective realities." From an abstract point of view there is a curious correlation to be found in the examples just given. The astronomer makes his calculations upon the vast elliptical orbit of the former, while the physicist makes mathematics explain the fitful gyrations of the latter. And we might pursue the analogy still further were it necessary.

While candidly admitting that much is being done to popularise the facts of physical science, it is surely justifiable to ask that the *rationale* of many of its doctrines should also be made sufficiently simple as to find ready access to minds of ordinary capacity. To take any material object and detail its various known properties in plain language is by no means difficult; but to describe the various known laws which govern its character is, on the other hand, not an easy task, for at this point we travel out of the region of the material into that of the immaterial. In other words, we move away from the domain of the concrete, and enter the kingdom of the abstract.

The bodily eye looks at the material, and then the mental one looks at the immaterial or invisible, and sees how inseparably connected is matter with force.

These observations may well apply to the remarkably interesting phenomena of Fluorescence, or "internal dispersion," for such are the terms given to the modifying effect produced by certain chemical substances upon a particular kind of light-energy which may be made to fall upon them. The phenomena appear to have been first observed in 1833, by Sir D. Brewster, in an alcoholic solution of the green colouring-matter of leaves.

About ten years later Sir John Herschel made further observations, and subsequently published a paper on the subject in the "Philosophical Transactions" for 1845. Since then Prof. Stokes, of Cambridge, and other observers in England and on the Continent have been making further researches in Fluorescence.

Without detailing the history of the investigations connected with the subject, we give our readers some of the more interesting and remarkable facts which have been gleaned of late years, as well as some account of the earlier discoveries.

If we put some common paraffin oil, or a solution of sulphate of quinine, into a glass tube or other suitable vessel, and then look through it, the liquid will appear quite colourless; but if we allow the light to fall upon it, and then view it at a little distance and at a certain angle, some parts of the liquid will present a delicate sky-blue tinge. The effect in the case of quinine is heightened if the source of light is burning magnesium wire.

The large number of substances belonging to this class are termed fluorescent bodies, because they exhibit phenomena similar to the examples above given. The term itself, however, was suggested to Prof. Stokes by a particular kind of fluor-spar which shows this property.

Again, if we cause a room to be darkened, and allow only blue light (*i.e.*, by covering a hole in a window-shutter with cobalt-blue glass) to fall upon a glass vessel filled with water which has been standing some minutes, on floating a strip of horse-chestnut bark upon its surface, in a few moments a stream of bluish grey fluid (æsculin) will be seen slowly descending from the bark, hanging, in fact, like a bunch of barnacles from an old ocean waif. Or if, under the same arrangement of light, or by using even more powerful absorbents of the ordinary rays (such as a solution of ammonio-sulphate of copper or one of chromate of potash), we look at a

piece of what is commonly termed canary glass,—*i.e.*, glass coloured with an oxide of the metal uranium,—it will be seen to glow as it were with rich greenish yellow rays, just as though it were itself a source of light; or if we take a solution of a uranium salt (the normal acetate) the phenomena are very striking when examined under the same conditions, and still more so by the electric light. But the salts of aniline—a substance which is the parent, so to speak, of mauve, magenta, and other brilliant colours—are singularly rich in exhibiting these effects.

A very beautiful experiment may be performed with the aniline red ink now so commonly in use. It affords, at one and the same time, an admirable illustration of Prof. Tomlinson's submersion figures and of the phenomena under consideration. If we take a long cylindrical glass vessel, or one with parallel sides, fill it with water, which is allowed to settle, and then gently deliver a drop of the red fluid to the surface, the drop begins to contract, and slowly from its centre descends in the form of a tube; the denser parts of the colouring-matter presently form a thick circular rim at the end of the tube,—but this is only for a moment, for a wavy edge appears upon this rim, then expands into a triangular parachute with a thickened edge, and from the extremity of each corner two or three smaller tubes descend; these in like manner pass through the same phases as the parent stem or tube. When this beautiful figure is viewed by transmitted light it exhibits the ordinary bright red colour; but when placed against a very dark background, and looked at from a little distance and at an angle, it is seen to be of a brilliant green,* very like a curious sea-weed serenely floating in a summer sea. Viewed vertically it presents a most singular shape, and glows with a fine golden tinge. Chlorophyll, the green colouring-matter of leaves before mentioned (those of the nettle are preferred), by reflected light is a bright green; but when a beam of white light concentrated by a lens is sent through it, the path of the beam is of a blood-red hue.

Crude resin oil, which is almost opaque, presents a delicate sky-blue fluorescence at its surface and the side opposite the light. One investigator has shown that some colouring-matters obtained from different woods, which though soluble in alcohol, alkaline solutions, or in alum, and not in this way sensitive, are very brilliantly fluorescent when dissolved

* The brilliancy of colour, of course, depends on the amount of diffused day light. The effects in each case are best seen on a bright day.

in castor oil: the most marked among these is camwood; in this medium it shows a strong apple-green fluorescence.

When paper is written upon with a tincture of stramonium seeds the characters are quite invisible by ordinary light, but appear self-luminous when exposed to highly refrangible rays, such as those given out by burning sulphur in oxygen.

Fluoraniline (obtained by acting upon aniline with chloride of mercury) is said to be one of the most powerful fluorescent bodies at present known.

The tinctures of several vegetable substances have a marked effect on light in this way: that of stramonium gives a pale but lively green fluorescence; guaiacum, a beautiful violet colour; turmeric, a greenish tint. Two artificial colouring matters, fluorescein and eosin, exhibit this property in a truly remarkable manner; but the effect is most brilliant in the green and blue portions of the spectrum (*i.e.*, the rainbow band of colour obtained by decomposing light by a prism).

A decoction of madder in a solution of alum shows a high degree of sensibility; it displays a copious yellow light. A weak solution of archil, which is red or purplish by transmitted light, gives a sombre green fluorescence.

But Stokes found that the electric light (from carbon-points) gave a spectrum, by the aid of a train of quartz prisms, which was more than six times the length of the ordinary spectrum. This light is in fact very rich in what are called the highly refrangible rays, and, moreover, its effect on fluorescent bodies was strikingly beautiful, and especially in the case of uranium glass.

As to the explanation of these phenomena, physicists are still somewhat at variance. But the experimental researches and elaborate reasoning of Prof. Stokes, who is at present the chief investigator in this department of inquiry, led him to the conclusion that beyond the visible spectrum there are certain rays which ordinarily are not sensible to the eye, but when these highly refrangible or much-drawn-apart rays are allowed to fall upon certain substances the molecules of these substances are made to vibrate in slower periods than the exciting rays, these molecular vibrations react on the ether, and consequently the rays on emerging (*i.e.*, on reflection) are hindered in their course and lowered in their refrangibility, that on being thus reflected they are brought within the range of vision: that is to say, if a ray of white light be made to traverse a prism, all those rays which go to make up the beam of white light, instead of passing through and being bent at the ordinary angle of simple reflection, are spread out like a fan; the degree of divergence

from the line of simple reflection represents the amount of refraction. The difference in degrees of refraction constitutes the difference between one colour and another, and one shade of colour from that which is akin to it.

That some rays are bent at a more acute angle than others is only another way of saying that they are more spread apart, dispersed, or more refrangible than others. For example, the yellow part of the spectrum consists of more refrangible rays than the red, and the violet than the green, and so on. But beyond each end of this rainbow band, or visible spectrum, there are the invisible rays. Those at the violet end are of very high refrangibility, and their motion as ether waves is also of very quick periods, while those beyond the red end are of low refrangibility and of comparatively slow undulatory periods. Now inasmuch as ordinary white light, or even diffused daylight, contains within itself those other highly refrangible rays, as well as those which are visible, it follows that when this light falls on a fluorescent body the substance absorbs or quenches those rays, and gives back rays which are of slower periods. This, then, is a kind of *selective absorption;* consequently those highly refrangible rays which, as it were, survive, in the course of their egress are evidently retarded within the molecules of the sensitive substance, to which molecules they impart their motion; these in their turn and by their movements excite or react upon the ether, and cause it to vibrate in waves of slower periods than the incident waves, which latter may be of any degree of refrangibility. It is very difficult to account for the phenomena otherwise. Moreover, it was found that if the incident light was polarised, the fluorescent rays from this source showed no traces of polarisation; they are, in fact, *always* unpolarised. Fluorescent rays were also found to be totally incapable of producing the same effect in a like sensitive body. And here it must be remarked that Prof. Stokes's original paper on the subject, entitled "On the Change of Refrangibility of Light" ("Phil. Trans.," 1852), furnishes one of the finest examples of inductive reasoning to be found in the literature of Physical Science. However, it must be borne in mind that some investigators are not satisfied with Stokes's theory, and especially when he laid it down as a law that the light emerging from a fluorescent body under excitation is *always* of lower refrangibility than the incident rays.

Thus Prof. Angström, while agreeing with Stokes in some respects, considers that the molecular motions of the sensitive substance, on the contrary, by acting on the lu-

miniferous ether, originate rays of higher refrangibility, the analogy to which might be, for example, as a higher octave in musical sounds. But this is considered by another authority as amounting to negative fluorescence.

M. W. Eisenlohr is of opinion that the phenomena are caused by the interference of the bluish violet and the ultra violet rays, which, it is argued, would give rise to rays of lesser refrangibility, in the same way as "combination tones" are of a lower pitch than the tones taken separately. But Prof. Bohn considers that according to this opinion fluorescence could never be seen in a spectrum that was pure, because "*there* rays of only *one* degree of refrangibility are to be found at the same place."

Prof. Lommel combines the theories of Stokes and Eisenlohr, but is of opinion that he has discovered a series of substances (anthracen-blue among others) which do not obey Stokes's law,—*i.e.*, that a body in the act of fluorescence never emits rays which exceed the refrangibility of the incident or exciting rays.

The results of Lommel's researches, it was reported, were coroborated by Brunner (of Prague) and Lubasch (of Berlin). But Hagenbach, the author of some very accurate studies of the phenomena, could not arrive at Lommel's results. M. Lamansky, however, after repeating the experimental work of his contemporaries, announced last year that, notwithstanding the facts and arguments adduced by Eisenlohr and others, he had nevertheless fully confirmed the validity of Stokes's law. This he accomplished by devising a means of *measuring the difference* between the incident or exciting rays and those simultaneously emitted by the substance under excitation,—*i.e.*, the fluorescent rays. This he ingeniously effected in the following way:—Reflecting the solar rays by a heliostat, and concentrating them upon a narrow slit by the aid of an achromatic lens, he then placed two flint glass prisms behind the slit and another achromatic lens, the latter being put at twice its focal distance from the slit. By this arrangement he obtained a spectrum of such purity that the chief lines were rendered visible. The spectrum was then thrown on the side of a box provided with a movable slit capable of adjustment to the several parts of the spectrum, and also provided with a means of widening or narrowing as might be required. Through this slit certain rays of the spectrum, which had been previously made to pass through a flint glass prism, entered the box, within which was a vessel full of fluorescent liquid: then by the aid of a reflecting prism these perfectly homogeneous

rays were directed upon the liquid. An achromatic lens was then placed between the surface of the fluid and the slit: a coloured image of the slit upon the liquid surface was thus produced. With another reflecting prism the fluorescent light was directed into the slit of the collimator of a Brunner's spectrometer. On looking through the instrument two coloured images appeared in the field of view; one was the fluorescent light, and the other that reflected directly at the surface of the fluid. Nothing more then remained to be done than simply to measure the minimum deviation of these two images. Each of the experimental measurements showed invariably "that the fluorescent substance has a lower refrangibility than the incident light."

Quite recently, however, Hagenbach has announced that after a prolonged investigation he has fully come to the conclusion that at present there exists no reason for rejecting the law of Stokes, and, moreover, that Lommel's classification of fluorescent bodies is not based upon any essential difference in their behaviour.

But the question as to the practical utility of these discoveries naturally arises. Science has a satisfactory reply. When each of these fluorescent bodies are examined with the spectroscope they exhibit well-marked and characteristic absorption-bands or dark spaces; consequently we have here a most subtle means of detecting their presence in a mixed solution or in a free state. Not only so, but Prof. Stokes has pointed out that if, on examining a solution in a pure spectrum, "we find the fluorescence taking a fresh start with a different colour, we may be almost certain that we have to do with a mixture of two different fluorescent substances, the presence of which is thus revealed without any chemical process."

Nearly two years ago, however, a most singular inquiry was brought to a satisfactory issue by the aid of fluorescence. It was long a question whether or not the head waters of the Danube found their way through subterranean passages into the Aach. The problem was thus solved: 10 kilos. about 22 lbs.) of fluorescein were poured into the first-named river, and three days afterwards a splendid green colouration with golden reflections (*i.e.*, its fluorescent effect) was quite distinct in the waters of the Aach. It was estimated that in this way 200 millions of litres of water were coloured by the presence of this substance. Doubtless Science will apply these beautiful phenomena to other and even greater ends than those which have yet been attained.

IV. GILBERT WHITE RECONSIDERED.

THE "Natural History of Selborne" is a quite exceptional phenomenon in English literature. We know no second instance of a scientific treatise which has become so general a favourite with the reading public, and of which new editions are still welcomed nearly a century after its first appearance. This lasting popularity is the more to be noted since the work is singularly free from all extraneous allurements. It is not seasoned with any of those sectarian and political condiments so dear to the British mental palate, and often obtruded upon us where utterly out of place. It is not garnished with tales of travel and adventure. It ministers little to the national love for sport,—*i.e.*, killing for the sake of killing. It is simply made up of careful observations of animal and vegetable life, told in the quietest and plainest language, and without any obtrusion of the author's personality. He is evidently anxious merely that facts should be ascertained and recorded, not that any *kudos* should accrue to him as their discoverer.

Herein lies his merit: he is a careful, patient, thoroughgoing observer. He seeks to know what birds are to be met with in the sphere of his observations, the parish of Selborne. He aims at identifying each species, at ascertaining its food, its song, its manner of flight, its breeding season, and mode of nesting. If not to be met with all the year round, he notes the times of its coming and departure, and asks whither it goes during the winter. Indeed, though not without doubts and misgivings whether our martins and swallows do not remain during the cold season in a state of torpidity, concealed in hollow trees, caves, and such like shelters, he throws a most important light on the migrations of the small birds. By the co-operation of his brother John, who resided for some time at Gibraltar, and who left at his death a MS. Natural History of that district, still unpublished, he ascertained that not merely the swallow tribe, but bee-birds, hoopoes, orioles, and many of the soft-billed

* The Natural History and Antiquities of Selborne, in the County of Southampton. By the Rev. GILBERT WHITE, M.A. The Standard Edition, by E. T. BENNETT. Thoroughly revised, with additional notes by J. E. HARTING, F.L.S., F.Z.S., &c. London: Bickers and Son.

summer birds, are seen crossing over from Africa in spring and returning thither in autumn. He points out that the difficulties of migration are thus far less than had been assumed by mere book-naturalists, since "a bird may travel from England to the Equator without launching out and exposing itself to boundless seas, and that by crossing the water at Dover and again at Gibraltar." He learns from his brother that the swallows are careful to select the easiest point, "sweeping low just over the surface of the land and water direct their course to the opposite continent at the narrowest passage they can find. They usually slope across the bay to the south-west, and so pass over opposite to Tangier, which it seems is the narrowest space."

He notes the absence of the nightingale in Devon and Cornwall, which "cannot be attributed to the want of warmth," but "is rather a presumptive argument that these birds come over to us from the continent at the narrowest passage, and do not stroll so far westward."

He concerns himself much with the peculiarities in the propagation of the cuckoo, and, though he fails to solve the difficulties which are here encountered, he refutes the conjecture of M. Herissant that the bird was disqualified for incubation by the peculiar structure of the digestive organs.

He observes a fact which some writers of books, even in our own days, have scarcely mastered, viz., that birds are much influenced in their choice of food by colour, and consequently must be able to recognise colour. He writes—"Though white currants are a much sweeter fruit than red, yet they [birds] seldom touch the former till they have devoured every bunch of the latter,"—an assertion which everyone who has frequented a garden will be able to confirm.*

He notices, at least as far as the swifts and swallows are concerned, the non-increase of birds. His explanation of this circumstance—*i.e.*, that the parent birds oblige their young to seek new abodes—is obviously one that will not bear scrutiny.

He notices the first appearance in his district of the cockroach,—an insect which had, indeed, been prevalent in London for a long time, but had not yet established itself in the country. It may not be here out of place to suggest how this vermin may have acquired its vulgar name of "black beetle." It may at first doubtless have been

* We have often asked why, in view of the superior quality of the fruit and its comparative immunity from birds, is the white currant so little cultivated?

confounded with *Tenebrio molitor* or with *Blaps mortisaga*, both of which are true beetles, both black, and which haunt bakehouses.

But whilst White's writings teem with facts which had escaped all previous naturalists, we find that, with trifling exceptions, all relate either to the locality or the habits of animals. With their structure, and even their outward appearance, he is much less concerned. He complains, with justice, of the vagueness of the descriptions of species given by the systematic writers of his time; but he does not attempt to amend their defect. He assumes each bird, &c., as a something known, and goes on to treat of its doings and its occurrence. Classification was as foreign to him as morphology,

We naturally ask what was his position with regard to the great questions of zoological philosophy, such as the origin, the persistence, and the distribution of species, their relations to each other, their dependence on climate, and diet? This enquiry appears the more reasonable if we reflect that he lived in the same century which produced the elder Darwin, and that he was acquainted with the writings of Buffon and Linnæus. Yet there is no evidence that he gave these subjects any especial consideration. He writes, indeed, that "Linnæus ranges plants geographically; palms inhabit the tropics, grasses the temperate zones, and mosses and lichens the polar circles; no doubt animals may be classed in the same manner with propriety. This is merely an assertion of the fact that different climates have their characteristic forms of animal and vegetable life. He speculates also on the origin of "those genera that are peculiar to America, how they came there, and whence?" Without hazarding an opinion of his own, he refers to the arguments of those writers who "stock America from the western coast of Africa and the south of Europe, and then break down the isthmus that bridged over the Atlantic,"—an hypothesis which he characterises as a "violent piece of machinery." Had he had any inkling of the doctrine of Organic Evolution he could scarcely have failed to bring it forward in this connection.

He observes, however, the influence of food upon the colouration of birds, and puts the question whether the variation in the colours of our domestic animals may not in part be due to more abundant and more stimulating diet?

He notices the helplessness of young swifts,—a fact which might have served for the better instruction of those writers who dwell so persistently on the precocity of

gallinaceous and natatorial birds and of ruminant mammals, as if common to the whole animal kingdom, save man only. Nor do we find him quite so often and so prominently as some of his contemporaries, posing in an attitude of wonder over the results of "instinct." He even notices the mistakes which birds may commit under the influence of this supposed faculty. By recording these imperfections and errors he strikes, in fact, a deadly blow at the existence of instinct as commonly defined and explained by the "philosophers," a definition to which he also elsewhere commits himself. In so doing he reminds us of Priestley, who, after he had discovered oxygen, remained an upholder of the Phlogistian system. He admits that "there are instances in which instinct does vary, and conform to the circumstances of place and convenience," and thus renders its diagnosis, as a faculty distinct from reason, impossible. Yet elsewhere he remarks, in self-contradiction, "Thus is instinct, taken the least out of its way, an undistinguishing limited* faculty." He gives one instance of a pair of birds devising an unusual expedient to meet a special and exceptional case in the nurture of their brood. Yet, considering how long and how carefully he observed the habits of animals, it is strange that he does not recount more cases of animal sagacity, or its opposite. Incidents narrated by him would have been valuable data, as we might have felt assured of his accuracy. In his day, however, the custom of referring all animal action to instinct was so universal that even the observant naturalists rarely troubled themselves to enquire further.

White must be pronounced less prone to teleology than most of his contemporaries—a highly creditable peculiarity if we remember the temper of the age in which he lived and wrote. In his sixth letter to Robert Marsham, of Rippon Hall, near Norwich, first published in the edition before us, he declares, indeed, that "physico-theology is a noble study, worthy the attention of the wisest man." We find also occasional quotations from, or rather references to, Derham. But those rhetorical outbursts on the harmonies and contrivances of the organic world which have played so decidedly into the hands of materialists, and injured the cause they were intended to serve, are here mainly conspicuous by their absence.

White was essentially a writer of the modern or real type, in contradistinction to the mediæval or verbal. These terms

* Is not reason a "limited" faculty, in many cases also "undistinguishing"?

may require some little explanation. Suppose that an author in the fourteenth, fifteenth, or even seventeenth century, had undertaken to write a history of the sand-martin. His first step would have been to collect all the names, learned or "trivial," by which the bird is known. He would have examined their origin, fancying thereby to throw some light upon the nature of the sand-martin, and quite forgetting that the name of a thing can tell us no more about such thing than was known to the person who first assigned it the name, and often embodies merely his erroneous notions. After having taken up a goodly space with this etymological game he would have made a laborious search through all accessible books, those especially of classical antiquity, for mention of the sand-martin. Every such passage he would have carefully quoted and commented upon. But it would never have entered his mind to examine a sand-martin,—to see with his own eyes wherein it agreed with, and wherein it differed from other birds, and in particular other members of the swallow group,—to observe its habits, its manner of feeding and nesting, and to note the localities where it occurs. Hence his learned and ponderous book would be a history not of the thing "sand-martin," but merely of the word "sand-martin," and of all the fables, dreams, and superstitions which had gradually adhered to the word, much like the droppings of rooks on the twigs below their nests. This manner of writing natural history originated with Pliny, and survived down to the middle of the seventeenth century. Gilbert White's method was the very reverse. Caring little as to what names might have been given to a bird, or what might have been dreamt about it by authors of old, he looked to the facts, observed patiently, and described clearly what he had observed. He cannot, indeed, be pronounced the pioneer of this reformation. Before him Marcgrave and Bontius had written local faunæ; Lister, Swammerdam, Willughby, and many others had studied Nature, not in books, but in things. Yet White succeeded in winning for his science a degree of popularity which in England at least it had never before enjoyed, and it thus fell to his lot to become the founder of a school of naturalists which has done good service, and which even yet is by no means extinct. We refer here not merely to his more direct followers, such as Jesse, Knapp, Jenyns, and Rusticus of Godalming. These writers have avowedly chosen White as their model, and acted upon his suggestions. Taking up some local centre, they have made its fauna and flora their especial study. We are far from undervaluing

these authors. Even Jesse, the least trustworthy of the group and the most inclined to put faith in mere hearsay evidence, scarcely deserves the severe sentence passed upon him by Waterton. But besides these imitators—if the reader prefers so to call them—White's indirect influence pervades English natural history to the present day. That tendency to study local faunæ which has so powerfully tended to constitute the science of Animal Geography, and has furnished such important data for the elaboration of the Doctrine of Descent, is thoroughly Whitean. We recognise it in our travelling naturalists, as well as in stationary observers; in T. V. Wollaston, in Belt, Bates, Wallace, Darwin, no less clearly than in White himself. It is somewhat remarkable that whilst England has been so fruitful in faunæ, in works descriptive of the habits of animals, and in contributions to the philosophy of zoology, she should be so poor in systematic works. We have no English Linnæus or Oken, Buffon or Cuvier. This is the more remarkable since in chemical science the English press has literally teemed with systematic treatises.

The question may here be raised in how far White can be held answerable for that morbid and narrow localism known as the "British" mania, which leads so many of our naturalists, commonly so called, to confine their researches within a boundary which is neither natural nor political, but an unhappy mixture of both. Thus they will take cognizance of a species found in Ireland, the Hebrides, or the Orkneys, but any form peculiar to the Channel Islands they ignore as "not British." We think he must be held guiltless. His object was to study the fauna of a certain district. The true "British maniac" aims more at collection than study, and, provided some one will guarantee that a specimen was captured within the four seas of Britain, he cares little for its exact locality.

It may not be uninstructive to contrast White with one who was his admirer,—to some extent his disciple,—and who cultivated with success the selfsame department of Natural History, becoming very eminent as an observer, whilst paying little heed to system or to the philosophy of zoology. Both these men rank among the happy few who are able to devote substantially their whole time to their favourite science; but their opportunities were otherwise exceedingly different. Gilbert White was no traveller; his days were spent and ended in his native village. An occasional journey to London and a few excursions in the southern counties seem to have formed the extent of his rambles: he

does not even appear to have visited the New Forest. Charles Waterton, on the contrary, passed many years in some of the most interesting parts of South America; he visited Canada, the United States, and the West Indies. He was familiar with Spain and Italy, and indeed with the entire of Western Europe. His own park, where 200 acres of land fenced in by a lofty wall afforded a happy shelter to all the birds of the North of England, might be considered an excellent ornithological station. He lived, too, in days when every branch of biology had made great advances as compared with the eighteenth century. But the results which he has bequeathed to the world do not surpass those left behind him by Gilbert White in the degree that might have been expected, either in quantity or in quality. It is probable, indeed, that Waterton must have made multitudes of observations, which from eccentricity he did not think fit to publish. He evidently paid a far greater attention to the structure of animals than did White, having, as he tells us, dissected 5000 specimens. But where are the results? Though second to no man, living or dead, in observing accurately anything that had actually passed before his eyes, he was inferior to White in critical acumen, and presented an odd mixture of obstinate credulity and of scepticism equally stubborn. Witness his persistent denial of the facts that serpents sometimes act on the aggressive, and that wolves hunt in packs; of cannibalism, of the rationality of the lower animals, &c.; and, on the other hand, his faith in phlebotomy and in the liquefaction of the blood of St. Januarius, and in "instinct." Where facts are wanting or doubtful White suspends judgment, but Waterton jumps to a conclusion. White, again, is gentle, unassuming, little disposed to criticise others, and eschewing controversy. Waterton, on the other hand, is irascible, pugnacious, never happier than when exposing the errors of Audubon or of the Quinarians. It must be admitted, however, that his temptations to severe criticism were such as never fell in the way of the kindly recluse of Selborne. What he might have said or done had he been shown a picture of a serpent with its poison-fangs pointing outwards, or had he been called upon to read and understand the works of Swainson, is another question.

Not the least pleasing feature in the works of Gilbert White is the thoroughness with which he, in old-fashioned phrase, "sticks to his text." He writes to give us his observations on Natural History, and his opinions on other subjects he keeps to himself. Though living in the stormy

and exciting times of the American War of Independence and of the first French Revolution, only once does a political reflection escape him. In the ninth of his recently discovered letters to Robert Marsham, he writes—"You cannot abhor the dangerous doctrines of levellers and republicans more than I do. I was born and bred a gentleman, and hope I shall be allowed to die such." Perhaps he was aware that political agitation is more hostile to scientific research than is even war. Waterton, on the other hand, is for ever obtruding his Catholicism and his somewhat anti-national politics upon our notice. We cannot help regretting that if he must write on such subjects he did not embody his opinions in distinct treatises, addressed to different classes of readers. Upon the whole we must pronounce White the superior, inasmuch as he made the better use of more limited opportunities.

Both these naturalists, it must be noted, protested—each in his distinct fashion—against the reckless waste of animal and especially of bird life, which still goes on. White complains bitterly of the persecutions to which our rarer birds are subject. We feel certain that the golden oriole, the hoopoe, and even the bee-eater, once ranked among our regular summer visitants. Perhaps their disappearance is due as much to the butchery which they suffer in Southern Europe as to their inhospitable reception on reaching our shores.

The present edition of "Selborne" presents certain recommendations. The ten newly-discovered letters to R. Marsham form a valuable feature, and the editor—unlike some of his predecessors—does not use the author's text as a peg on which to hang irrelevant notes for his own glorification.

V. THE FOUR FORCES IN NATURE.

By George Whewell, F.I.C., F.C.S.

THE forces in Nature may be divided into four kinds, and we assume that all atoms are endowed with these four forces, either in an active or latent condition.

We have ventured to call these four forces "Viva." The word Viva is used as a limited expression for the term "life," and means, in the physical world, the motion which produces expansion and contraction, which causes molecules to assume the form of solid, liquid, gas, or ultra gaseous.

In the case of animals and plants it means the force which causes the ascension of the sap of plants, the movement of the substances of the body, such as the circulation of the blood, the secretions, &c., the contraction of the muscles, the production of sensation and thought.

The four forces are Atomic Viva, Organic Viva, Animal Viva, and Mensic Viva (mind).

Previous to the Great Creator calling the world into active existence three of these forces were in a state of combination, and atomic viva alone was active.

The environment of the atoms in the process of evolution determined the development of organic viva; then animal viva; and, lastly, mensic viva (mind).

Life cannot exist without heat; deficiency of vital heat is weakness or disease; absence of vital heat is death to organic, animal, and mensic viva. Heat is a mode of motion, and caused by the vibration of atoms; all atoms vibrate more or less. The ultimate composition of the universe is therefore *Vibration and Heat.*

That the forces of the physical world—such as light, heat, electricity, chemical action, &c.—are modes of motion are quite agreed to by philosophers. This mode of motion we have given the name Atomic Viva.

Atomic viva is therefore a mode of motion. Taking the embryo as a type of our second force, we find the first indication of animation is a minute pulsating point. It is the development of our second force, organic viva; the cause of existence—the distinction between atomic and organic viva. This motion causes the formation of the young heart, which in its turn causes the propulsion of the infant stream.

With the motion of the heart begins life; with its stoppage begins death. It is by this motion that arteries, veins, capillary vessels are formed and receive the vital fluid. With the circulation begins secretion, then digestion, then nutrition. These functions are closely related and dependent on each other; one cannot stop without the whole circle stopping. It causes the formation of brain nerves and muscles. It is anterior to animal viva, which begins at birth. Organic viva begins with this first motion, is complete at birth and continues without fatigue, and is never for a moment suspended until the stoppage of the motion, which we call death.

Heat is produced by the first and subsequent pulsations. Organic viva is therefore a mode of motion.

At birth is developed our third force, animal viva. This force does not come into existence until the new being

becomes detached from its mother. It then for the first time comes in contact with external objects; its organs being complete, all the functions of its economy can be carried on, and it enjoys independent existence. The power of the brain to control the actions of the voluntary muscles is weak at first, and gets strength slowly; it comes to perfection at adult age.

We have seen that organic viva exists before animal viva, and it may exist after animal viva has ceased. The two forces are distinct, and come into action at different periods. When sensation and the power of voluntary motion are abolished, animal viva is extinguished, yet the whole circle of the organic functions—such as circulation, respiration, secretion, excretion—may continue to perform their rightful duties. As in the case of apoplexy the greatest intellect and the strongest muscles may be rendered powerless, never to come into action again, it may totally extinguish animal viva, yet the involuntary contractions of the muscles and the action of the heart may not be impaired, but rather strengthened, and organic viva may go on for days.

Catalepsy may abolish sensation and volition, and cause the muscles to contract and remain fixed, yet the heart continues to beat, the pulse to throb, and the lungs to respire, and all the organic functions of the body continue in full force.

From the above it will be seen that animal viva may perish, both the sensitive and motive portion of it, and yet organic viva continue in operation and full force.

Animals possess three forces,—atomic viva, organic viva, and animal viva,—the latter being controlled by the will. Will is common both to man and animals, and will and mind are not one and the same thing. Animal viva produces heat, and heat is a mode of motion. Animal viva is therefore a mode of motion.

Man possesses the four forces—atomic viva, organic viva, animal viva (which includes will), and mensic viva (mind). This latter motion, although blended with and essential to a well-developed man, is independent and distinct from organic and animal viva. Organic viva is born at the moment of the development of our second force; animal and mensic viva not until a later period. These latter forces are feeble at birth, and acquire strength by slow degrees, and attain their ultimate perfection (in the case of animal viva at adult age) later in life.

Taking the lowest form of plant-life we find the lowest developed form of organic viva, the power of assimilation

and growth, and ascending the scale we come to those plants possessing in a remarkable degree sensitiveness and the power of digestion and assimilation. Plants and animals possessing organic viva only have not the power of voluntary motion, but either remain fixed or—if free to move—have no control of their movements.

In the lowest forms of animal life we find the lowest developed form of animal viva, viz., sensitiveness, given by the possession of nerves and muscles. As we ascend the scale we find this sensitiveness concentrated, and forming what is called the brain. It is this sensitiveness which educates the brain, and causes some of the higher animals —such as the horse, dog, elephant, parrot, &c.—to have the power of remembering, and in some cases almost to think and to reason.

In the case of those animals which have memory we have the beginning of the development of mensic viva; and in those animals with both memory and slight reasoning we have a still further development of mensic viva, until we come to the lowest form of man, when we have the lowest form of mensic viva (mind), which is the power of reasoning, and is found in the greatest perfection in Christ, and in our Shakspeares, Miltons, Newtons, Davys, and Faradays. This power gradually diminishes as we descend the scale, until we come to those semi-animals who are the lowest form of human beings.

Man can have organic and animal viva well developed, and mensic viva strong, as in the case of the philosopher; weak, as in the case of the imbecile; or suspended, as in the case of the lunatic. The mind may for ever remain blank, as in the case of one born whose brain is not developed, or only capable of slight cultivation although fully developed, as in the case of one born deaf and dumb, and blind.

If we go a step further, and conceive a human being born deaf and dumb, blind, and without sensitiveness, such an individual might be fully developed, but yet would remain a perfect blank so far as possessing any knowledge of this life. On the other hand, man can have mensic viva strongly developed, and animal viva partially or wholly suspended, as in some cases of paralysis, when he has lost entire control of his limbs or some important part of his body, and still retains all his reasoning faculties. *Cæteris paribus*, the higher the mental power and the lower the organic and animal viva, and also the higher the mental power and the lower the power possessed by man of procreating his species.

Great men never have a numerous progeny. This is accounted for by the fact that the greater the mental power, and the more it is used, the more blood is required to renew the tissues of the brain; consequently the generative apparatus suffers. On the other hand, low brain power and physical exertion determines the blood to the lower parts of the body, and increases the sexual desires. This is the reason why ignorant and low forms of human beings have a greater progeny, and bring them into the world with less pain and trouble than the more cultivated.

When, in the highest form of animal, mensic viva was sufficiently well developed, and the animal became responsible for his actions to the Great Creator (it was thus that man discovered his nakedness), then he acquired the power of transmitting the fourth force (mensic viva) to his offsprings.

In the same way the animal or plant has the power of transmitting, to a full-developed offspring, organic and animal viva without mensic, or organic without animal and mensic viva.

The missing link between the highest animal and the lowest man need not be looked for in his physical appearance, such as the wearing away of the tail of the monkey, but in the transition from animal to mensic viva. Will is common both to man and the higher forms of animals, and is possessed by those animals whose sensitiveness is concentrated, and forms what is called the brain. Will serves as a connecting-link between man and animals.

When man's sexual passions are excited, heat is developed at the back of the head (cerebellum); when man's virtuous passions are excited, heat is developed at the crown of the head; when man's reasoning and thinking faculties are excited, heat is developed at the forehead.

When we think heat is produced we use up a portion of the substance of the brain; and there can be no heat and no waste of the brain without work, and there can be no work without motion.

Mensic viva is therefore a mode of motion.

ERRATA.

Page 381, line 10, *for* "lightning" *read* "lighting."
Page 383, last line, *for* "would require" *read* "would *not* require."
Page 390, line 5, *for* "proportions" *read* "propulsion."
Page 556, line 5 from bottom, *for* "motion" *read* "motive."

ANALYSES OF BOOKS.

Nature's Hygiene. A Series of Essays on Popular Scientific Subjects, with Special Reference to the Chemistry and Hygiene of the Eucalyptus and the Pine. By C. T. KINGZETT, F.C.S. London: Baillière, Tindall, and Co.

WE have here an interesting treatise on a subject which is by no means exhausted. The author contends that these are the great natural agents for the destruction of those mysterious entities—be they organised or not—which are the cause of epidemics. The first fact to be taken into account is the remarkable immunity from fevers and other pestilential maladies enjoyed by the great island-continent of Australia. Such diseases, if introduced into Melbourne or Sydney, die out without spreading. This circumstance is the more remarkable if we reflect that no especial care has been bestowed upon sanitary arrangements in the colonies, and that, judging from the latitude and the temperature, Australia might seem a fair field for cholera, yellow fever, or plague. Its soil and atmosphere are certainly dry, but these features are no less to be recognised in Persia, Asiatic Turkey, certain regions of India, North Africa, Mexico, and La Plata, where pestilence is far from uncommon.

Of late years it has become prevalent to ascribe the remarkable sanitary advantages of Australia to its woods of different species of Eucalyptus—a vegetable genus not naturally occurring in any other part of the world. Nor can we pronounce this opinion baseless. It seems perfectly well established that certain spots in Italy, Algeria, &c, previously notorious for their unhealthiness, have been rendered perfectly safe by the introduction of this tree. The generally received explanation of the sanitary activity of the various species of Eucalyptus is that they exhale large quantities of a volatile oil. It has further been discovered by the anthor that this oil, and indeed all the oils upon which the aroma of herbs and flowers depends, generate peroxide of hydrogen by their action upon air and watery vapour. Now as peroxide of hydrogen acts very energetically upon decomposing animal and vegetable matter, we can see why a Eucalyptus forest should have a beneficial effect upon the health of the surrounding district.

There are still, however, a few questions to be answered before we can lay claim to a full knowledge of malaria and of disinfection. We learn that in Queensland, in regions where the odour of the Eucalyptus is very distinct, ague is not unknown,

though it is never either as prevalent or as intense as the "fever and chills" of Louisiana or Georgia. We further find that in South Africa—and not merely in the old Cape Colony, but in Natal—the so-called zymotic diseases are rarer than in most countries of a similar climate, especially those in the northern hemisphere. Yet here the Eucalyptus is naturally absent; nor are trees of the pine kind, if at all indigenous, found to such an extent as to affect the atmosphere. This leads us to another consideration. Mr. Kingzett classes the pine along with the Eucalyptus as a sanitary agent. He even says—"It is probable that the hygienic influence of the pine is much greater than that of the Eucalyptus, since it has a much wider and more extensive distribution in Nature." We ask, therefore, whether there is any country which enjoys in virtue of its pine-forests an immunity from pestilence similar to that which Australia derives, or is supposed to derive, from the Eucalyptus? Russia, Norway, British North America, and the more northern States of the American Union, are all, or were all, rich in pine-woods. From their latitude and climate they are not likely to suffer from yellow fever, nor, over the greater part of their extent, from ague; but they have been visited by cholera, typhus, and small-pox. Russia and Norway, like the rest of Europe, did not escape the "black death." Germany, Austria, Switzerland, and Italy, have all their pine-forests; but they have from time to time been scourged with plague, and in more recent times with cholera, dysentery, diphtheria,* and, at least as far as Italy is concerned, with malarial fever of the deadliest type. We naturally wish to learn whether the spread and the virulence of this disease has been found to be at all influenced by the local presence or absence of pine-forests. Has the sanitation of any unhealthy district been attempted by planting pine-trees? If so, with what success? and if not, why not?

We think it will be found that a country partially wooded, irrespective of the nature of the trees, will be found more healthy than one completely cleared, but otherwise similar, and that denudation is generally attended with an increase of sickness. The back-woods of South America are healthier than the towns and plantations. The Pontine Marshes are treeless. Woods regulate the temperature of any locality, and above all render its changes less abrupt, and by so doing may modify the character of the fermentations and putrefactions which organic refuse undergoes.

It must not be supposed, from these remarks, that we wish to dissuade those interested from planting the Eucalyptus in insalubrious districts. We wish these experiments to be multiplied, and we shall be very glad if any species of this tree can be found

* We learn from the "Victorian Review" that the town of Hamilton, near Melbourne, is now suffering from a severe outbreak of diphtheria.

adapted to an equatorial in contradistinction to a merely tropical climate, and consequently suitable for introduction into Sierra Leone, the Gold Coast, and similar regions. Are there any species of Eucalyptus indigenous in New Guinea? If so, they will probably meet the emergency.

As regards the origin of the "zymotic" diseases, Mr. Kingzett does not accept the "germ theory," against which he, following Dr. Drysdale, advances arguments which cannot be ignored.

Believers in ozone will derive little edification from this work. They will learn—what is utterly beyond dispute—that most of the observations made as to the presence or absence of this agent are inconclusive, and that the commonly received notion that zymotic disease prevails inversely as its proportion in the atmosphere is simply baseless.

Mr. Kingzett's book may be read with great advantage, and will do good service in enlightening the public mind on many points connected with health and its preservation. An index would have been useful.

The Truth about Vaccination. An Examination and Refutation of the Assertions of the Anti-Vaccinators. By Ernest Hart. London: Smith, Elder, and Co.

The Anti-vaccination movement is being carried on with a zeal and a pertinacity which, even in these days of professional agitation, must be pronounced surprising. We cannot help wondering where the promoters of the outcry—none of whom are known to us even by name—find the two essential requisites, dupes and funds. That money is forthcoming is evident, from the quantity of documents, pamphlets, and advertisements which the anti-vaccinators issue in support of their views, and which, if feeble in argument, are remarkably strong in assertion.

On Sunday, July 25th, emissaries were posted near the doors of a number of places of worship in the north of London, and tracts denouncing vaccination were handed to the congregations on leaving. We are bound to say that, to our knowledge at least, this proceeding did not in any way receive the countenance of the clergy and ministers. Surely, when such means are resorted to, it is incumbent upon the intelligent part of the community not to rely upon the inherent absurdity of the movement, nor to hope that if left alone it will die a natural death. Disease-germs, moral and social as well as physical, show a wonderful vitality. So long as an ignorant and excitable community coexists with eloquent sophists who can gain fame, power, and perhaps more tangible rewards, by organising

ignorance and appealing to public "conscience," so long watchfulness and unceasing efforts will be required "*ne quid detrimenti respublica capiat.*" Mr. Hart has therefore done well in issuing the pamphlet before us, which we hope may be as widely circulated as the errors which it exposes and refutes.

Amongst the items of the "anti-vaccination creed" which the author endeavours to extract from the bundles of tracts sent him, one of the most prominent is that compulsory vaccination is an infraction of the "liberty of the subject." This objection, if it can be maintained, strikes at the root of sanitary legislation altogether. If a man has the right of neglecting a known precaution to diffuse small-pox among his neighbours, he has the same right by neglecting other precautions to make his person, his family, and his house a focus of diphtheria, scarlatina, typhoid, or cholera: he is justified in travelling in a public conveyance when suffering from infectious disease; in allowing sewage, &c., to run into wells and streams used for the supply of drinking-water; and, indeed, in setting fire to his house, regardless of the danger to his neighbours. All this, and much more, follows by logical sequence if we once deny the right of the community to coerce a refractory anti-vaccinationist. We cannot recognise the vested rights of disease. If vaccination is really a safeguard against small-pox, then the individual who rejects this protection is much more to be censured than the suicide. If the latter fails in effecting his purpose we punish him far more severely than the anti-vaccinationist, though his offence cannot possibly injure the public. No more valid is the "conscience" plea. It is a most remarkable fact that the greatest wrong-doers in the world—witch-burners, inquisitors, Thugs, Torquemada, Cotton Mather, Robespierre, and the like—have been conscientious men. But no well-ordered community would on that account give scope to their propensities. It seems to us that the magistrates, in dealing with "Peculiar People" who have allowed their children to die rather than call in medical aid, have been somewhat mistaken in entering upon this "conscience" question at all. If the neglect is once proved, why should the court inquire as to its motive?

An objection is sometimes raised against vaccination to which Mr. Hart does not refer. We have heard it argued that the small-pox cleared away the sickly and debilitated part of the population, who, if suffered to survive, would have died of consumption, scrofula, general debility, and perhaps have become previously the parents of unhealthy children. But is it certain that the small-pox showed so much discrimination in the selection of its victims? We suspect not: except we are strangely misinformed, healthy children, the offspring of sound and vigorous parents, were not unfrequently swept away.

It is sometimes asked, how it comes that small-pox epidemics are still possible, and that the disease has not continued to decline

as vaccination became more general? Why, in spite of compulsory vaccination, did deaths from small-pox rise in the year 1872 to a number exceeding anything recorded in the previous seventeen years? Mr. Hart contends that the proportion of deaths from small-pox to the total pupulation from 1838 to 1853, being prior to compulsory vaccination, was 420 per million; whilst during the succeeding twenty-six years of compulsory vaccination, 1854 to 1879, the death-rate in question had fallen to 208·5 per million. He argues that a great many persons, though nominally vaccinated, have not in reality been successfully operated upon, and are consequently unprotected. The proportion of deaths from small-pox in the earlier part of the century is not given, and indeed cannot be accurately ascertained, as there was in those days no accurate and general registration of deaths and their causes. Still it might be estimated as closely as the mortality from 1728 to 1757, and 1771 to 1780, which is given as 18,000 per million. This omission in Mr. Hart's pamphlet is the more to be regretted as an impression prevails that the disease nearly died out from 1810 to 1830, and has since 1838 undergone a recrudescence.

The contention that vaccination may be the means of introducing other diseases, and especially syphilis, cannot be set aside as out of the question. J. Simon, F.R.S., in a paper on "Contagion" ("British Medical Journal," December 13th, 1879, p. 923) declares that "even in states of chronic dyscrasy, and even at times when the dyscrasy may be giving no outward sign, the infected body may be variously infective; . . . . the vaccine lymph of the syphilitic infant may possibly contain the syphilitic contagium in full vigour, even at moments when the patient who thus shows himself infective has not on his own person any outward activity of syphilis." Of course no medical practitioner in his senses would knowingly use lymph from a syphilitic infant for vaccination. But does he always know the health-record of the parents? It is therefore a wise precaution to use lymph which has not circulated through the human system. Had this step been taken years ago the only rational argument of the anti-vaccination party would have been rendered non-existent. It must, however, be noted that no case of the transmission of syphilis along with vaccine lymph has been demonstrated. Had such cases existed the agitators would not have been silent.

The Brain as an Organ of Mind. By H. Charlton Bastian, M.D., F.R.S. London: C. Kegan Paul and Co.

Dr. Bastian is chiefly known to the general public as an advocate of the somewhat heterodox theory of spontaneous generation,

or, as it is now somewhat more pompously called, abiogenesis. In opposition to Pasteur, Tyndall, and others, he maintained that under favourable circumstances life may take its origin, not from any ova, germs, or spores, but from lifeless matter. In how far he still upholds this view, now it has been shown that certain microbia are capable of existing at far higher temperatures than was once supposed, we are not aware. The present volume, however, is of a less speculative character. The author lays before his readers facts on which there is now little difference of opinion among men of science.

As may readily be supposed from the title, the work is very comprehensive in its scope. Starting with the uses and origin of a nervous system, Dr. Bastian gives a general account of nerve fibre-cells and ganglia, and of the use and nature of the organs of sensation. He describes in succession the nervous systems of the Mollusca, Vermes, and Articulata. He next describes the brain of fishes, Amphibia, reptiles, and birds. At this point of the animal scale we are introduced to the questions of the scope of mind, reflex action and unconscious cognition, sensation, ideation and perception, of consciousness in the lower animal, of instinct, nascent reason, emotion, imagination, and will. Returning to things visible and tangible, the author describes the brain of quadrupeds and some other mammals, and that of the Quadrumana. Surveying the mental capacities and powers of the higher brutes, he very justly gives the first rank to the anthropoid apes. Too many writers, we may here remark, confound docility with intelligence, and in enlarging upon the reasoning powers of the dog forget that he exhibits the hereditary influence of an education which has extended over many generations, whilst the ape, caught wild, and rarely surviving above a couple of years in captivity, is observed at a disadvantage.

Next we are introduced to the most interesting and important part of the subject—the human brain. Here the reader will meet with many facts perfectly well established, but scarcely in harmony with popular notions. He will learn that the brain of man belongs to the same general class as that of the apes and monkeys, and that, though the difference in weight between the brain of the large anthropoids—such as the orang and gorilla—is great, the range met with among individual men is still greater. Concerning the lack of symmetry in the corresponding convolutions of the two cerebral hemispheres, it is remarked that the same want of symmetry is met with in the elephant and the whale. Careful examination of series of skulls, mediæval and modern, show that the cranial capacity—the size of the space filled by the brain—has distinctly increased during the last seven centuries. Another remarkable fact, pointed out by Vogt and Le Bon, is, the difference between the sexes as regards cranial capacity increases with the development of the race, the male

European surpassing the female to a greater extent than is observed among savages. The difference between the average capacity of the skulls of modern Parisians, male and female, is almost double that which prevails between the skulls of male and female inhabitants of ancient Egypt. Further, as civilisation progresses, the range of variation among male individuals increases with the position of the race in the scale of civilisation. Thus among negroes large and small male skulls may vary by 204 cubic centimetres; among ancient Egyptians by 353; among twelfth century Parisians by 472; and among modern Parisians by 593. Hence Le Bon holds that the real test of superiority of one race over another in regard to cranial capacity is not to be ascertained by averages, which are often deceptive, but by observing how many individuals per cent in different races possess skulls of given volumes.

An important conclusion here at once suggests itself, viz., that the progress of the race is towards greater diversity, and that the revolutionary doctrine of equality has no natural foundation.

Some interesting conclusions are also reached concerning the average weight of the brain in different European nations. The mean weight of the English brain is given by Boyd at 47·8 ozs., and by Peacock at 49; that of the French, 47·9; of the Germans at 48·3; and of the Scotch at 50. On the other hand, the weight of the negro brain is given by three authorities as 44·2, 44·3, and 44·5 ozs. respectively. The brain weight of the male negro is therefore the same as that of the European female, and falls short of the male European by 5 ozs., or about 11 per cent. The Chinese brain is remarkably heavy. The eleven adult males whose brains were weighed belonged to the lowest class, and were all chance victims of the cyclone of 1874. Yet they showed an average weight of 50·45 ozs., exceeding therefore that of the English, Scotch, French, or Germans! The great size of the brain in the Lapps and Esquimaux is mentioned, but no weights or measurements are given.

Le Bon carried out a series of measurements of the heads of Parisians belonging to different classes of society. He found the largest size among the scientific and literary class; next followed the commercial world; then nobles of ancient families; and lastly domestic servants. We believe that in England also the heads of footmen, grooms, &c., have been found smaller than those of any other class.

A small size and weight of brain have been long ago laid down as ranking among the characteristic features, and indeed among the causes, of idiocy. Broca places the limit compatible with ordinary human intelligence at 37 ozs. for the male and 32 ozs. for the female. But in a number of cases given by Dr. Thurnam and others the brain-weight ranges from 35·76 down to 8·5 ozs., the scale among the anthropoid apes being from 16 to 12 ozs. The converse statement, that a brain of unusual size necessarily

accompanies and indicates intellectual superiority, is quite unfounded. Brains far above the average may be observed among lunatics. At the Wilts County Asylum, in 10 per cent of the males and 7 per cent of the females who died there, the brain-weight exceeded the upper limit of the medium size, being 52½ ozs. and 47½ ozs. respectively, while in from 3 to 4 per cent the weights were respectively 55 and 50 ozs. In an asylum in one of the northern counties Dr. Clapham found, among seven hnndred male brains, forty-three the weight of which exceeded 55 ozs, and reached in four of them 60 to 61 ozs. The heaviest brain weighed by Dr. Thurnam (62 ozs.) was that of a butcher who was just able to read, and who died of epilepsy combined with mania. The heaviest brain weighed by Dr. Bucknill—64·5 ozs., equal to that of the celebrated Cuvier—was that of a male epileptic. The brain of a female monomaniac weighed by Dr. Skae was 61·5 ozs., a monstrous weight for a woman.

Brains of unusual weight may also be found among persons not indeed lunatics, but quite ordinary, common-place characters, who have never displayed any high intelligence. The heaviest human brain on record (67 ozs.) was that of a Sussex bricklayer who could neither read nor write, and who died of pyæmia in University College Hospital, in 1849.

Nor must it be forgotten that though certain eminent men have had very large brains, others, perhaps not less eminent, have but little exceeded the mean standard, or even fallen below it. Hence, as the author remarks, there is no necessary relation between the mere brain-weight of individuals and their degree of intelligence.

A most interesting chapter is that headed "Phrenology, Old and New." But into this, as into many other portions of Dr. Bastian's work, space will not allow us to enter. For all who wish to acquire a general knowledge of the structure and functions of the brain and nervous system, human and animal, without dissecting, or consulting the original documents scattered through the scientific journals and the transactions of learned societies, the book before us will prove a most valuable guide.

We cannot help pointing out that in one passage (p. 211) the "Journal of Science" is mis-quoted as the "Quarterly Review of Science."

Abstract of a Discourse on Ornament, delivered at the Royal Institution, June 4th, 1880. By H. H. Statham.

An interesting pamphlet, but dealing with a subject as regards which we must admit ourselves outsiders. The concluding remarks have a special claim upon our attention:—"One aspect

of the subject may be touched upon in conclusion which seems to connect it with the great modern all-pervading idea of Evolution. For though we cannot historically trace back all the forms of ornament to their origin, we can see enough to leave no doubt that if we had all the connecting-links before us we should find that many of the most admirable, widely used, and characteristic forms of ornament originated not so much in any sense of beauty as in mere superstition and grossness; and that ornaments are habitually used in our churches and public buildings and habitations the actual though remote origin of which, were it hinted at, would very much astonish those who execute and those who admire them; and it may, perhaps, be accepted as one more illustration of the upward tendency of human development that even the very knowledge of this uncomely side of the subject has fallen away from all except those who have had special reason to study its history, and that from these clods of earthiness and superstition there has sprung this bright and innocent flower of ornament-"

A lesson worth pondering over!

The Life of Thomas Wills, F.C.S., Demonstrator of Chemistry, Royal Naval College, Greenwich. By his Mother, MARY WILLS PHILLIPS, and her Friend, J. LUKE. London: James Nisbet and Co.

BIOGRAPHIES have latterly become exceedingly plentiful, and we not unfrequently open a goodly volume recording the being and the doings of some person of whose very existence we were in utter ignorance, and should have been contented so to remain. Such is not the case with the memoir before us. Though called from our midst at the early age of twenty-eight, he had already earned for himself an honourable name in Science, and had he survived he would doubtless have bequeathed to the world a treasure of valuable results. His first paper communicated to the Chemical Society was on the "Solidification of Nitrous Oxide," February 20th, 1873. On June 13th, of the same year, he laid before the Society an account of an "Ozone Generator" which he had devised. In September, the same year, he entered upon his duties at the Royal Naval College. His lectures delivered before various societies and associations were numerous, and his depth of thought and clearness of exposition were fully recognised by his hearers. His last paper read before the Chemical Society, December 19th, 1878, treated on the "Production of the Oxides of Nitrogen by the Electric Arc"—a subject which he was still investigating up to the time of his death.

Thomas Wills, however, was by no means exclusively a chemist or a physicist. He was passionately fond of music, and even took pleasure in listening to speeches in the House of Commons. He was as active in connection with Sunday-schools and Young Men's Christian Associations as with the Society of Arts, the Royal Institution, or the British Association.

We think that had he survived his influence would have done much to allay that feeling of uneasiness, if not of actual hostility, with which the advances of Science are viewed by the religious world. He felt deeply that men of Science are doing God's work in every investigation and every discovery. We honour this spirit, and regret that it is not more general and better recognised where it does exist.

For the student the brief career of Thomas Wills is rich in useful lessons. May they be appreciated as they deserve!

Journal of the Society of Telegraph Engineers. Edited by W. E. Ayrton. London: E. and F. N. Spon.

This issue contains a goodly assortment of interesting communications. Among these particular attention is due to a paper entitled "A Decade in the History of English Telegraphy," by Mr. E. Graves; and one on "The Behaviour and Decay of Insulating Compounds used for Dielectric Purposes, by the President of the Society, Mr. W. H. Preece. This memoir includes a history of gutta-percha, with a notice of the causes which lead to its destruction. A minute insect, *Templetonia crystallina*, gnaws into it, and actually seems capable of thriving upon a substance which to us seems the very type of indigestibility.

In some localities the mycelium of a fungus has been supposed to be an active agent in the decay of the gutta-percha coating of underground telegraph wires, but on insufficient evidence. It seems that oxidation is the main cause of decay, and that it takes place wherever gutta-percha is exposed to air, or alternately to air and moisture. The outer layer of the substance becomes dry and brittle, and changes into a resin, soluble in alcohol. This fact alone explains the reason why gutta-percha has fallen into disuse as a material for jugs, funnels, measures for liquids, &c.

Histoire des Coléopteres de France. Par le Dr. SERIZIAT. Précédée d'une Introduction a l'étude de l'entomologie, par M. CH. NAUDIN. Ouvrage adopté par le Conseil de l'Université. Paris: Firmin-Didot et Cie.

To understand why, even within the limits of one and the same great zoological region, certain species stop short at boundaries not apparently marked with any great distinctness by a change of climate and productions, we require, in the first place, local faunas drawn out with precision. We seek to be enabled to trace upon the map the exact range, if not of every species, still of the representative forms of each group. Every step taken in this direction reveals to us relations previously unsuspected. We all know that within an epoch which geologically speaking is but as yesterday, England and France formed one country, connected together by land, where now roll the waters of the Channel. We know that in climate the southern counties of England differ little from the northern and north-western departments of its continental neighbour. Yet when we compare the insects of the two countries—and we select them for comparison as being less modified by human intervention than the mammals, birds, or reptiles—we perceive at once a most remarkable difference. Species entirely wanting in England make their appearance across the Channel; others, rare in this country, become at once common; and yet others, present in both countries, are found to select different stations. It is especially to be noted that certain forms, which with us are almost confined to the seacoasts, are found on the Continent in inland situations. The question then arises whether the species wanting in Britain had found their utmost northern limit before its separation from France, or whether they at one time occupied England and have since become extirpated?

The work before us will prove a very useful document for the student who enters upon such enquiries. Though it does not profess to give an exhaustive catalogue of the Coleopterous fauna of France, similar to the "Manual of British Beetles" by Stephens, it furnishes an account of the characteristic forms of each group. Entomologists collecting in France will find it an excellent guide what to seek and where to seek it. The descriptions of species are generally more complete than those of Stephens, and the illustrations, which are numerous, will prove of great assistance to the beginner in the recognition of species. To some of them objection may be taken. Thus *Polyphylla fullo* is correctly described in the text as possessing very large antennæ, the club of which in the male is seven-jointed; yet it is figured with smaller and less distinctly clavate antennæ than *Melolontha vulgaris*. *Calosoma sycophanta*, very rare and littoral

in England, is described as nowhere common in France, though more plentiful in the south than in the north, and as abundant in Algeria. This fine species has therefore a wide range, since in some parts of Eastern Europe, though local, it may be gathered up in hundreds; and we fear that its splendid colouration may some day attract the notice of those who purvey decorative insects to milliners, and thus ensure its extirpation. It would almost seem as if, in the more eastern parts of Europe, the "Mediterranean" and "European" subregions of the Palæarctic region were less distinctly severed than in the more western parts. Is this because extreme climates are more favourable to insect life, or because in Eastern Europe the Mediterranean basin is not fenced off from the central plain by such unbroken barriers as the Alps and the Pyrenees?

It is painful to learn that the beautiful species *Carabus rutilans*, once common in the Eastern Pyrenees, has now become very scarce, and that *C. hispanus* is undergoing the same fate in the Cevennes.

The Buprestidæ, which in England are exceedingly rare, not a few species being doubtful, are in France sufficiently numerous to rank among injurious insects. Their larvæ are described as particularly numerous to pear trees. We find no mention of *Chrysobothris chrysostigma* and of *Ancylochira octoguttata*, both of which are found in Central Europe, and we should think might naturally be expected to occur in France.

We may strongly recommend this little work to all entomologists who wish to obtain a general oversight of the French Coleopterous fauna. We do not know any other work which, under this head, supplies so much information in so little compass.

We regret, however, to point out that, in the introductory chapter on the study of Entomology, M. Naudin goes somewhat out of his way to pronounce man entitled to rank in a separate kingdom, distinct from the animal world, and known as the kingdom of reason! We had hoped that the day for such consecrations of popular prejudice had passed away.

Revue Internationale des Sciences Biologiques. July 15, 1880.

We give from this journal an abstract of a paper by Dr. Hovelacque, on the "Characteristics of the Inferior Human Races.' On the length of the cranial vault the writer lays no emphasis, remarking that the anthropoid forms of Africa (gorilla, chimpanzee) are dolicocephalous, whilst those of the Eastern isles (mias, gibbon) are brachycephalous. The cranial capacity he

considers a valuable characteristic, the cubic contents in the white race sometimes exceeding 1600 cubic centimetres, whilst in more than one of the dark races it does not exceed 1200. It may here be remarked that in the Esquimaux the cranial capacity does not fall short of the average European standard.

A peculiarity of the lower races is the less degree of complication of the cranial sutures, which approximates them to the anthropoid apes. In them, as in the apes in question, the obliteration of the sutures proceeds from the front to the back,—that is to say, commencing with the region corresponding to the nobler faculties of the brain. It is the same in the apes, but not in the white man, in whom, further, the ossification of the sutures is notably less precocious. Among the dark races the frontal part of the cranium occupies less room, both in width and length, than it does in the higher races, which is again a Simian feature.

Another characteristic of the inferior races is the considerable development of the face in proportion to the total head. The lower races approach the apes by their wider sphenoidal angle, which measures 135° in the European, 145° in the negro, 150° in the chimpanzee, and 170° in the orang. The inferior races have also a wider nasal aperture, and the nasal bones become united at an earlier epoch—also a Simian characteristic. In the white races the parietal and the sphenoid are articulated together, whilst the frontal and the temporal are joined by a more or less horizontal suture, measuring 1 to 2 centimetres. In the apes this arrangement is reversed, the frontal and the temporal being articulated, whilst the parietal and the sphenoid are connected by a vertical suture—a structure frequently found in the dark races. These latter races are also characterised by their prognathism. At the same time the lower jaw sometimes even retreats as in the pre-historical specimen of Naulette, which is almost completely Simian. In the aborigines of Australia and New Caledonia the three large molars are nearly equal. This is a transition between the decreasing form in the white race and the increasing in the apes. The canines are also stronger in the Australian than in the European—another Simian feature. The elongation of the pelvis is another characteristic which approximates the lower human forms to the apes.

The author then justly and truly declares that the anthropomorphoid apes have, like man, two hands and two feet; they are neither quadrupeds nor quadrumanes.

If a brief digression may be permitted we would express our surprise that any one, after seeing the skeleton of a gorilla, can persist in calling this huge ape "quadrumanous." Its foot has a decided heel-bone, like that in the foot of man, which is wanting in its hands. But the hands and feet of the apes are, as we might expect, less specialised than those of man; yet in the lower human races the use of the foot is less exclusive than

in the white man, and it is more capable of grasping. In certain inferior races the tibia is transversely flattened, as in the apes; their anterior limbs are also longer in proportion to their hind limbs than in the higher races.

M. Hovelacque gives a further distinction which we cannot accept:—"A not less striking characteristic of inferiority is that of credulity, of faith, of religion, whatever it be. The idea of fetiches, of gods, of Deity, is the peculiar property of the lower races; and the more or less gradual abandonment of these conceptions, puerile but dangerous, is an evident character of the superiority of a race. Faith in the higher races is merely an affair of education and of intellectual sloth."

Traité d'Anæsthésie Chirurgicale, contenant la Description et les Applications de la Méthode Anæsthésique de M. Paul Bert. Par le Docteur J. B. ROTTENSTEIN. Paris: Germer Baillière et Cie.

THE means of annihilating the pain formerly an invariable and fearful attendant upon all surgical operations have not unnaturally attracted a large share of public attention, and it might be possible to name reputations which have been cheaply earned by the persistent recommendation of new anæsthetics.

The author pronounces artificial anæsthesia to be "the greatest scientific conquest of our age, and the greatest discovery which has been made in Medicine, with, perhaps, the exception of vaccination." The glory of the invention he ascribes to Horace Wells. Still he quotes the words which Sir H. Davy had used in his pamphlet on Nitrous Oxide, published as far back as 1799:—"Pure protoxide of nitrogen appears to possess, among its other properties, that of destroying pain, and may probably be employed with advantage in surgical operations not attended with a great effusion of blood." Well may Dr. Rottenstein exclaim "l'idée était là." Surely we may submit that the merit of Davy in connection with anæsthesia was not inferior to that of the man who forty-five years later put this published proposal into execution.

The principal object of the work before us appears to be the recommendation of the anæsthetic method of M. Paul Bert. It is found that, though the inhalation of nitrous oxide produces complete anæsthesia, this state cannot be prolonged for the time necessary for the majority of surgical operations, since symptoms of asphyxia soon appear, and prove rapidly fatal if the inhalation of the gas is continued. M. Paul Bert has overcome this difficulty by administering a mixture of equal volumes of nitrous oxide and of air under a pressure of two atmospheres.

The work is illustrated with cuts of the apparatus required for administering the various anæsthetic agents.

Report upon Cotton Insects, prepared under the direction of the Commissioner of Agriculture in pursuance of an Act of Congress approved June 19th, 1878. By J. H. Comstock, Entomologist to the Department of Agriculture. Washington: Government Printing-Office.

Some little time ago we attempted, with but scanty apparent success, to draw attention to the need of more efficient protection for our small insectivorous birds. Casting about for arguments and pleas more effective than any we had used, we come upon the work before us, and find here plain facts more than sufficient for our purpose. The damage done to crops by certain insects is here set forth in such a matter-of-fact style that any man of common sense can scarcely avoid two conclusions: that flies and caterpillars, and other the like buzzing, creeping things, are by no means the contemptible trifles commonly supposed, but are well worth the attention of practical men; and, secondly, that whatever natural agents can protect our fields and gardens from their ravages deserve not merely protection, but formal encouragement. It is somewhat strange that, though we have had acute observers of insect and bird life for more than two centuries, yet the public mind is less alive to these truths in England than in the United States. Though we still keep up the farce of professing to be a practical people, we accept the ravages of vermin as a necessity, and neither enquire what is the total of the damage sustained, nor if there is not the possibility of a remedy.

They manage these things differently in America, as Mr. Comstock's work most clearly shows. It appears that a single Lepidopterous insect, a mere moth, inflicts upon the cotton-growing States losses which are estimated at from 15 to 20 million dollars annually for the entire period since the Civil War, whilst there is good reason for supposing that prior to 1861 this insect was equally destructive. The same enemy, *Aletia argillacea*, infests the cotton plantations of South America and of the West Indies, and in some of the latter has absolutely caused the cultivation of this staple to be abandoned. If we call to mind that the figures above given show merely the loss inflicted by one insect upon one crop, we may form some faint idea of the world's vermin-bill, and the extent to which the human race is impoverished by creatures which some persons affect to consider worthy the attention merely of children or of industriously-idle old gentlemen.

The author's account of the natural enemies of the cotton-worm is exceedingly interesting. Among them figure swine, dogs, cats, racoons, the common "leather-wing" bat, domestic poultry, and almost all the insectivorous birds of the Southern States, among which the king-bird (*Tyrannus carolinensis*) and the mocking-bird (*Mimus polyglottus*) are perhaps the most efficient.

Some planters have been tempted to call in the aid of the English sparrow, the introduction of which into America may be regarded as one of the most ill-advised pieces of "acclimatisation" ever perpetrated. Every naturalist knows that this marauder, though it feeds its young on insects, is yet during its adult life by preference a devourer of grain and fruits. Their hostility to the harmless and useful swallow-tribe is ground enough for their death-warrant. We are therefore by no means surprised that the sparrow is decidedly condemned by such eminent authorities as Dr. Elliott Coues. Our American friends will find, however, that the elimination of this pest, wherever it is once introduced, is a matter of extreme difficulty, since every known scheme for its destruction acts also upon those species of birds which it is desirable to preserve.

Next follows an enumeration of the invertebrate enemies of the cotton-worm, including spiders, dragonflies, bugs, beetles, ants, wasps, and a group of two-winged flies, of which the principal species are *Erax apicalis* and *E. Bastardii*. These creatures are sufficiently powerful to overcome even bees, wasps, and hornets, whose sting seems to have little effect upon them. They certainly destroy numbers of the cotton-moth; but these flies occasion such losses to the bee-keeper that their services in other respects are more than outweighed. A fly of this kind has been known to kill more than a hundred bees in a single day. The *Erax*, though so fearfully carnivorous in its adult state, commences life as a vegetarian.

The interesting experiments made by the author to induce the destruction of the cotton-worm through the action of Fungi gave only negative results. He considers it, however, by no means improbable that some practical and economical method of parasitising noxious insects may yet be discovered.

Experiment with poisons have also been made. It seems to us that the wholesale use of such agents as arsenious acid and potassium cyanide is fraught with very serious danger.

It appears that while *Aletia argillacea* is ruinous to the cotton plantations in its larva state, when mature it occasions no little damage to peaches, grapes, figs, melons, &c. These epicurean propensities seem to point to the possibility of destroying the enemy by means of poisoned sweets, but no very decided success has been achieved.

The "boll-worm," *Heliothis armigera*, is considered as scarcely less to be dreaded than the cotton-worm, and it extends its

ravages to maize, the tomato, peas, beans, vegetable marrow, hemp, tobacco, and lucerne.

An interesting essay is appended on the nectar of plants and its uses. The author remarks—"Nectar is secreted apparently to attract insects to a plant, and some of the insects so attracted oviposit on the plant, on the foliage, flowers, and fruit of which their larvæ feed. How could this secretion have been acquired by natural selection? It looks as if such an acquisition must imply the survival of the unfittest. . . . It appears that the secretion of these glands first attracts the worst enemies of the plant, and then attracts their enemies, which afford it partial relief from the misfortune that it has brought upon itself."

This essay will well repay thoughtful study, and must be pronounced as interesting in a theoretical light, as are the former portions of the book from a practical point of view.

What constitutes Discovery in Science? By GEORGE M. BEARD, A.M., M.D. New York.

IN this thoughtful and eloquent pamphlet the author contends that the first honour in Science belongs to him who organises. "To organise a science, to vitalise it, so that it may live and grow, is to make oneself expert in it, and to point out the way for others also to become experts." Dr. Beard holds that all new ideas before their full and final reception pass through three stages of evolution. In the first they are simply ignored; in the second they are denied; and in the third strenuous efforts are made to show that the fact or theory is old as the hills—"that Newton and Faraday, Hunter and Harvey, Fulton and Morse, were but feeble and conscienceless imitators, and that Edison is one of the few Americans who never invented anything." Every discovery dates from the time when it is made a part of the organised knowledge of men. That somebody may have dreamt of the thing long ago, or suggested it as one among many guesses, detracts nothing from the honour due to the man who first brings it out into full daylight. In all this we are thoroughly at one with the author. But when he says that those who are active in contesting the priority of discoveries, and who "drink the past to its dregs for proofs that the world's work has not been done by its workers" become themselves original in their search, we entertain strong doubts.

Elements of Chemistry, Theoretical and Practical. By W. Allen Miller, M.D. Revised and in great part re-written by H. E. Armstrong, Ph.D., F.R.S., and C. E. Groves, F.C.S. Part III.—*Chemistry of Carbon Compounds, or Organic Chemistry.* Section I.—*Hydrocarbons, Alcohols, Ethers, Aldehyds, and Paraffinoid Acids.* Fifth Edition. London: Longmans and Co. 1880.

The "Elements of Chemistry" of the late Prof. W. A. Miller has for years enjoyed a high reputation, both as a manual for the more advanced student and as a work of reference for persons engaged in research, whether of a more theoretical or practical character. Many a time, when some rather out-of-the-way question has arisen and authorities were being appealed to, we have heard the exclamation "To save time, look in Miller!" Even yet, among the chemical "handbooks," "manuals," and "elements," in which the English press has been so alarmingly prolific, this our old favourite has continued to hold its own. But in chemistry, more perhaps than any other science, with the doubtful exception of biology, discoveries have been made so numerous and important that no systematic work can continue to meet the wants of the student unless it too advances in a corresponding manner. The task which Dr. H. E. Armstrong and Mr. Groves have undertaken, and which they evidently wish to carry out without sacrificing those features which have rendered the work in its original form so valuable is not easy. New discoveries are rarely mere additions which can be simply intercalated among what was already known; they shed fresh lights upon the older parts of the science, and necessitate modifications. Prof. Miller's system of classification, based as it was mainly on the sources from which the various compounds were obtained, has been of necessity abandoned in favour of an arrangement based on analogy in constitution and properties.

The edition before us, so far at least as the present volume is concerned, may almost rank as a new work in which have been retained all such portions of the original as have been not essentially affected by recent discoveries.

Among the portions entirely novel we may call attention to Section XI., in which the hypothesis of isomerism proposed, independently of each other, by Van't Hoff and Le Bel, is expounded and discussed, but with the conclusion that it is probably insufficient.

The preface also, which contains some useful suggestions, is worthy of careful notice.

The table of contents is copious and the index excellent—a feature for which we have a special affection. We consider, in fine, that the authors have succeeded in their object of laying

down a solid foundation for the chemistry of the carbon compounds, and we warmly recommend their work to the scientific world.

Bulletin of the Philosophical Society of Washington. Vols. I., II., and III.

We have here the proceedings of a learned society founded in 1871, and extending from that date down to June 19th of the present year. The papers read are naturally of a very mixed nature. Some which, judging from their titles, must be exceedingly interesting are merely mentioned,—*e.g.*, one on the "Origin of the Chemical Elements," by Mr. L. F. Ward. Others, on the contrary, which, whatever their value, seem to us more suitable for a Chamber of Commerce than for a Philosophical Society, are inserted in full, and occupy a very large share of space.

We may mention a memoir, very briefly given, on the "Geographical Distribution of Mammals," by Mr. T. N. Gill. The author concludes that at a remote epoch Australia, South America, and Africa had been colonised from one common source, and might be grouped into the division *Eogaea*, contrasted with the rest of the world, named *Pleiogaea*. Of the Eogaean regions Africa has received the greatest number of intrusive elements.

The Glacial epoch and its causes appear to have been the subject of frequent discussion.

The paper "Common Errors respecting the North American Indians," by Mr. Mallery, contains much interesting matter for the consideration of ethnologists. It retains and consecrates, however, the greatest error—the application of the term "Indians" to the aborigines of the Western continent.

The following extract from the opinions of the late Professor Joseph Henry, the first President of the Society, deserves quotation:—"When, from the likeness between the Infinite Mind and the finite minds made in His image, it was sought by *à priori* logic or by any preconceived notions of man to infer the methods of the Divine working, or the final causes of things, he suspected at once the intrusive presence of a false as well as presumptuous philosophism, and declined to yield his mind an easy prey to its blandishments. To his eyes much of the free-and-easy teleology with which an under-wise and not over-reverent sciolism is wont to interpret the Divine counsels and judgments seemed little better than a Brocken phantom."

United States Entomological Commission. No. 4. *The Hessian Fly.* Washington: Government Printing-Office.

THE Hessian fly ranks among the more destructive of the noxious insects of the United States, and pays its unwelcome attentions principally to wheat. So serious have been its ravages that the cultivation of wheat in the New England States was abandoned about twenty years ago, and is only now being resumed. The more interest attaches to this insect as it is aboriginal not in the United States, but in Central Europe, and only became noxious in America about a century ago.

The Hessian fly is as unlovely in its appearance as in its propensities, being, except as regards its antennæ, a miniature crane-fly. It has fortunately a diligent enemy in *Semiotellus destructor*, a parasitic ichneumon of the family Chalcididæ, which in some seasons disposes of nine-tenths of the Hessian fly.

Mineral Statistics of Victoria for the Year 1879.

FOR the first time for many years the annual yield of gold shows a slight increase on that obtained during the previous season, and amounts to 758,947 ounces. Extensive and highly auriferous quartz-veins have been discovered near Ballarat.

The total yield of silver was 23,729 ounces, all parted from gold, no silver-ore having been raised.

Only 24 tons of tin-ore have been obtained. The yearly produce of copper-ore has been 3862 tons, and of antimony 495¾ tons.

No lead-ore and coal have been raised, and only 120 tons of iron-ore.

The Journal of the Royal and Archæological Association of Ireland. Vol. V., No. 40. (Fourth Series.)

IT appears that at present the most scandalous destruction of important antiquities, cairns, cromleacs, &c., has been going on at Devenish and Bundoran. Mr. E. H. Cooper gives a catalogue of fifty-one monuments, most of which have been damaged, and some entirely destroyed. We trust that Sir John Lubbock will before long succeed in getting his Bill for the preservation of such remains safely through Parliament.

Mr. R. J. Usher has discovered a submarine crannoge under high-water mark at Ardmore Bay. It is suspected to have existed from times when the British islands were connected with the Continent.

Fashion in Deformity. A Discourse by Prof. W. H. FLOWER, LL.D., F.R.S., &c., delivered at the Royal Institution, May 7th, 1880.

A POPULAR but correct account of the various mutilations and disfigurements of the human person practised at the dictates of fashion, from the perforated noses and lips or distorted skulls of savage tribes to the cramped feet and waists of so-called civilised Europe and America.

Let the British public read this pamphlet, and then believe, if it can, the assertion that fashion is an aiming after ideal beauty!

Several important books stand over for review, on account of the want of space.

CORRESPONDENCE.

, The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

AN ANTI-MATERIALIST ARGUMENT.

To the Editor of The Journal of Science.

SIR,—Presuming that you do not object to a brief and temperate criticism on views advanced in your Journal, I venture to offer a remark on a passage in your September number. The Bishop of Carlisle is quoted as saying that a murderer "has no doubt as to the fact that the person who did the deed of darkness years ago is the same person as he who feels the pangs of remorse to-day. Every material particle in his body may have changed since then, but there is a continuity in his spiritual being out of which he cannot be argued." Your contributor apparently agrees with the Bishop, for he adds:—"In so far as this consideration is an evidence against what is commonly known as Materialism, I appreciate its value."

This argument, it seems, assumes that any impression made on a system of ever-changing material particles cannot be permanent; and that the continuity of consciousness and memory proves the existence of an underlying spiritual—at least non-material—being.

But we find that impressions made upon our bodies, in spite of the continuous change of matter, may yet become permanent, the new particles being deposited in the old mould. To take an instance:—I have on my left wrist a small scar, the result of a mishap in my schoolboy days. Upwards of thirty years have since gone by, and every atom in my wrist has doubtless been replaced more than once. Still the scar remains; as old matter is withdrawn new matter takes its place and formation.

If the experience of our lives leaves impressions of any kind upon the brain,—though I by no means maintain that such impressions are scars,—why may not permanence be obtained in an analogous manner?—I am, &c.,

A LUCRETIAN.

THE DEFENCE OF VIVISECTION.

To the Editor of the Journal of Science.

SIR,—I fear that the greatest peril to vivisection arises from the want of unity among its defenders. Medical practitioners are too apt to view it as an exclusively professional question. Hence as a body they refuse to co-operate with non-medical biologists, naturalists, &c., and to ignore the action of non-medical journals like your own. If they would consider the number of fanatics who are being enlisted by the "suppression societies," and the unscientific journals who give in their adhesion to the party of ignorance, they would, I think, welcome all allies.—I am, &c.,

GRADUATE.

"DR." TANNER'S FAST.

To the Editor of the Journal of Science.

SIR,—I am perfectly amazed to find that certain papers, supposed to address a class of readers not wholly devoid of culture, seem to believe that Dr. Tanner's success in his sensational experiment really proves, as he supposes, that the majority of mankind take too much food. Now, whether the fast was *bona fide* or not, and whether the conclusion is in itself true or false, its truth does not in the least follow from the successful issue of the experiment.—I am, &c.,

SCRUTATOR.

NOTES.

THE Swansea meeting of the British Association, from whatever causes, has been one of the least numerously attended of these annual gatherings since many years. A distinguished American scientist informed us that he had had the pleasure of reading a paper before the Chemical Section to an audience of eight persons! The Inaugural Address of the President, Dr. A. C. Ramsay, F.R.S., was naturally devoted to geology. He upheld the multiplicity of glacial epochs, with the inferences necessarily following, and gave in his decided adhesion to the doctrine of Uniformity, as will appear from the conclusion of his Address :— "If the nebular hypothesis of astronomers be true (and I know of no reason why it should be doubted), the earth was at one time in a purely gaseous state, and afterwards in a fluid condi tion, attended by intense heat. By-and-bye consolidation, due to partial cooling, took place on the surface, and as radiation of heat went on the outer shell thickened. Radiation still going on, the interior fluid matter decreased in bulk, and, by force of gravitation, the outer shell being drawn towards the interior, gave way, and, in parts, got crinkled up, and this, according to cosmogonists, was the origin of the earliest mountain-chains. I make no objection to the hypothesis, which, to say the least, seems to be the best that can be offered, and looks highly probable. But, assuming that it is true, these hypothetical events took place so long before authentic geological history began, as written in the rocks, that the earliest of the physical events to which I have drawn your attention in this address was, to all human apprehension of time, so enormously removed from these early assumed cosmical phenomena that they appear to me to have been of comparatively quite modern occurrence, and to indicate that from the Laurentian epoch down to the present day, all the physical events in the history of the earth have varied neither in kind nor in intensity from those of which we now have experience. Perhaps many of our British geologists hold similar opinions, but, if it be so, it may not be altogether useless to have considered the various subjects separately on which I depend to prove the point I had in view."

Prof. F. M. Balfour, as President of the Anatomical and Physiological Department of the Biological Section, took for the subject of his opening address the recent progress in Embryology.

Mr. F. Galton, during his discourse on "Mental Imagery," exhibited the photograph of a "generalised" Welsh Dissenting

Minister, formed by taking the common features underlying a number of actual portraits.

M. A. Netter has addressed to the Academy of Sciences a note entitled "An Experimental Fact demonstrating that Ants have neither an Antennal Language nor any Exchange of Ideas." The nature of the fact has not yet transpired.

Dr. Sternburg, after examining microscopically the blood of yellow-fever patients at New Orleans, has been unable to find any "germs" or figured ferments which might be the cause of the disease.

Prof. Alexander Agassiz, in an able address delivered before the American Association for the Advancement of Science, objected to the "genealogical trees" of animal groups.

According to a memoir presented by M. J. Kunckel to the Academy of Sciences, the chrysalides of Lepidoptera suspend themselves by the hooks of the membranous anal feet, which are modified and adapted to particular biological conditions.

M. Alph. Milne-Edwards reports on the dredging operations conducted in the Bay of Biscay by the French ship *Le Travailleur*. As regards the Crustacea there are two supposed faunæ which do not mix, none of the species dredged up having been found on the adjoining coasts. The Mollusca found at great depths are identical with those of the Norwegian and Arctic Seas.

In "Science," July 24th, we find a most interesting paper by H. F. Jayne, on Monstrosities observed in North American Coleoptera. The most remarkable specimen figured is one of *Prionus californicus*, in which each femur bears two tibiæ, duly furnished with tarsi and claws. A hasty observer would pronounce the insect twelve-legged.

A race of domestic cattle found in Senegambia, belonging to the Zebu group (*Bos indicus*), present, according to M. de Rochebrune, the exceptional characteristic of a true horn on the nasal region, identical in its nature and mode of development with the frontal horns. It is common to both sexes, and is sometimes conical, but more generally takes the form of a four-sided truncated pyramid, about 2¼ to nearly 3 inches in height. The skeleton differs altogether from that of the zebus of India and Madagascar. The incisors have on their outside a deep groove.

M. H. Filhol has presented to the Paris Academy of Sciences a memoir on new fossil mammals discovered in the phosphatic deposits of Quercy. The most interesting of these forms is *Ailurogala acutata*, a connecting-link between the Felidæ and the Mustelidæ.

The "Comptes Rendus" contains an account of deforming pilosism in plants. The author distinguishes physiological pilosism, the increase of hairs upon plants produced when they are removed from a humid to a dry medium; teratological pilosism, which extends so far as to create suspicions of a new species, and due to disarrangement of the process of nutrition; and vulnerary pilosism, produced by the stings of insects, as in galls. It is quite localised, and does not mark the physiognomy of the species.

M. E. Spée, in a memoir communicated to the Belgian Academy of Sciences, proposes that the so-called "helium" line, in the solar spectrum, D_3, is a hydrogen line.

P. Kaiser ("Botanische Zeitung") shows that the trunks of trees are subject to a daily-recurring, regular change of diameter. which decreases from the early morning, and reaches its minimum in the early hours of the afternoon. Then a gradual increase begins, till a first or smaller maximum is reached at the approach of darkness. After a short decrease the diameter rises again, and reaches its larger maximum about dawn. The author considers that temperature is not the only factor concerned.

The maximum temperature in the shade registered at Melbourne Observatory has been 111·2° F., and the lowest 27°.

Mr. W. G. Lapham ("American Journal of Microscopy") points out as a serious evil that many biological terms are incapable of definition.

Prof. H. L. Smith, in an article inserted in "Science," admits that the wax-cell is a failure.

The experiments of Prof. Prentiss ("American Naturalist"), of Mr. W. Trelease, and Prof. J. H. Comstock, on the use of yeast for the destruction of noxious insects, have had a negative result. On the other hand, Dr. Hagen and Mr. J. H. Burns have been to a certain extent successful.

Mr. C. O. Whitman ("American Naturalist") maintains that flying-fish really flap their pectoral wings when in the air, and are capable of altering their direction without touching the water.

Mr. T. Mellard Reade ("Geological Magazine") combats the notion of the general permanence of the present main features of the continents and oceans, as asserted by Agassiz, Dr. W. B. Carpenter, and others.

According to H. H. Howorth ("Geological Magazine") the name Mammoth is a corruption of Behemoth, which the Arabs, who confound M and B, pronounce Mehemet.

At the Astor Library, New York, out of a total of 56,891 volumes given out for the year 1879, there were only 142 on

zoology and 214 on biology, whilst theology numbered 2231, ecclesiastical history 2402, music 1462, and jurisprudence 3284.

The two heaviest gold nuggets found in Victoria from October, 1877, to June 30th, 1879, weighed respectively 20 lbs. 10 ozs. and 23 lbs. 6 ozs. troy.

Psilomelane containing from 1 to 7 per cent of cobalt is obtained in many localities in Victoria, and is profitably worked by a process devised by Mr. Malcolm Hills ("Geological Survey, Victoria," vi.).

According to the Rev. G. K. Morris ("American Naturalist") *Pheidole pennsylvanica*, an ant found in New Jersey, is a true harvester.

Mr. E. J. Hill, writing in the same journal, describes a non-poisonous snake which very successfully mimics the rattlesnake.

A honey-collecting ant with an enormously distended abdomen has been discovered in Australia.

M. Adalère Liénard has communicated to the Academy of Sciences of Belgium a memoir on the nervous system of the Arthropoda and the constitution of the œsophagian ring, in which he recognises four distinct types:—that of the Crustaceans; that of the *Dytisci*, common to a great number of carnivorous insects; that of *Cossus ligniperda*, which occurs in the larvæ of many moths, locusts, and herbivorous or lignivorous beetles; and finally that of the suctorial insects. (It is strange to find the brain of *Necrophorus vestigator* and *N. germanicus* belonging to the first of these types, whilst the kindred form, *Silpha nigrita*, is assigned to the third.—Ed. J. S.)

According to the "Geological Magazine" an entirely new fauna has been detected, in the Menevian States of St. David's and of Dolgelly, which were considered wholly unfossiliferous. The fossils were discovered by looking at the bedding-ends of a number of the slates placed together in their natural position.